A New Paradigm,
Solving The Nation's Energy Waste In Heating-A/C

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Abstract

The nation's 89 million heating, ventilation and air-conditioning (HVAC) systems have a serious problem. While operating on average 34% below their efficiency standards, they waste nearly 212 billion kilowatt hours (kWh) of electrical energy—enough energy to power 17.2 million additional homes for one year. The primary reason for such waste by these systems has to do with a concept this report terms as "starved airflow," that is, the restriction of air at the evaporator coil, which often causes the HVAC system to run at only approximately 65% of its seasonal energy efficiency ratio (SEER) capacity.

This report argues that such an astronomical amount of energy waste can be remedied by directing engineering know-how and new technologies at the millions of existing HVAC units already in place. Knowing how to eliminate the key airflow chokepoints—such as restrictive filters, dirty, contaminated e-coils, and undersized return air ducts—can overcome much of the problem. Replacing the HVAC filter with Force-Field electromagnetic energy and hydroxide catalytic reaction eliminates one of the largest sources of contamination, energy loss and airflow restriction in the entire system. And there are other benefits to replacing the filter with newer technology. Much of the airflow restriction caused by undersizing return-air ducts (the filter being the culprit), is eliminated, and another chokepoint is thereby purged from the system. By also using Force-Field at the e-coil (converting it to self-cleaning), the third major chokepoint is eliminated, completing the critical task of ringing out the residue of energy waste rampant in the nation's under-performing HVAC units. But after the chokepoints are neutralized, there is a final step to gain the highest performance possible from the system, and that is to fine-tune the fan speed, refrigerant charge and watt usage, adjustments that can be calibrated by a fully-integrated diagnostic computer, a device that is novel for the HVAC industry.

This report also makes a long-term recommendation for better HVAC system performance with gas and oil furnaces: make the e-coil first in-line, followed by the fan and then the furnace. This arrangement frees up airflow by eliminating resistance of the furnace and overcoming the distance from the fan (much like the HVAC electric furnaces and heat pumps). This corrections does not need to be made on the millions of existing systems, but should be implemented over time as a matter of a few engineering adaptations.

But without the necessary expertise, these critical adjustments would never happen. The custodian of these changes should be a certified contractor that has been schooled in these novel methods and techniques from the HomeGreen.X program. Through this program, HVAC contractors are certified in the application of Force-Field processing, diagnostic computing, database site certification, green labeling, and green home licensing overlays. When the HomeGreen.X concept model is applied by the contractor, a synergism takes place across the entire range of energy uses, making the energy savings for any given home greater than the sum of the adjustments.

Introduction

As previously discussed, the nation's 89 million HVAC systems consume close to 624 billion kWh of electrical energy, accounting for about 44.5% of the total energy use in American homes. Unfortunately, these millions of systems operate at approximately 34% below their efficiency standards, wasting some 212 billion kWh of electrical energy, enough energy to power 17.2 million homes for one year. On a per-home basis, the energy consumed by HVAC systems is five to twenty times more than the rest of the devices in the home combined. On top of the energy inefficiency of these systems, they generate up to 6 times more indoor pollution (toxins, germs, molds, allergens, house dust) than any other source.

The uncomplicated, underlying reason for such waste by HVAC systems has to do with something this report terms "starved airflow." To operate effectively, HVAC units need 400 cubic feet of air per minute (CFM), yet America's 89 million systems function with an average of 265-270 CFM—a discrepancy that accounts for much of the lost billions of kWh of energy.

In order to overcome this enormous source of energy waste, the HVAC industry must make changes to outmoded techniques and methods. Without such critical adjustments, the waste will only increase, exacerbating the nation's already debilitating energy over consumption. This report presents a plan that can make the already-existing 89 million HVAC systems more efficient, as well as techniques for field-assembling new units with high quality methods.

Fundamentally, this report is about an adjustment of mind, philosophy, and methods, made possible by the application of simple steps. In short, the article argues that a paradigm shift in the industry and in society is necessary. But to make this shift is going to require the efforts of contractors, manufacturers, government agencies, utility companies and knowledgeable individuals. The potential payoff for such a paradigm shift is huge: overcoming the largest single source of energy waste nationwide. Such a prospect aligns itself with perhaps one of the nation's largest social and political concerns—energy efficiency and independence, pollution reduction, and the adoption of more sustainable "green" practices in America's homes.

Old Strategies, Outdated Concepts

Skyrocketing energy costs have begged the question, how do we save energy in the short run? Conservation strategies are certainly an important part of cutting energy costs, but the question is what types of conservation approaches should be used. The approach often used is to encourage consumers to replace older, inefficient automobiles or home appliances with newer and more efficient ones. But for most consumers, this investment only pays off in the long run, rather than alleviating short-term energy concerns. The same problem makes replacement of HVAC systems to achieve energy savings impractical in the short run. It may, in other words, take 25 years or more before the consumer sees a real return on his or her investment.

In short, the prospect of energy savings in the HVAC industry is an exceptionally complex endeavor. Government regulations make the implicit recommendation that energy savings for HVAC systems will come from replacing older, inefficient HVAC units with newer, more efficient 13+ SEER systems. On paper, this approach appears tenable. However, simply improving the lab-tested SEER ratings of new systems will take many years to improve the energy efficiency of the nation's stock of HVAC systems. Furthermore, even if a majority of consumers replaced their inefficient HVAC systems with new, higher-SEER systems, the energy savings is likely to be minimal. The problem is that nearly all newly installed HVAC units are not meeting the decreed standards. The *actual* in-home efficiency of a system is dependant on a number of variables and conditions that are often not controlled for in the lab tests which determine a particular systems SEER rating. And a system's efficiency only wanes with age. This makes it nearly impossible to reach the energy goals projected many years down the road. In other words, replacing old systems with newer units is not going to solve the problem until there are some fundamental changes on how existing and new systems can be made to operate at optimal levels and thereby meet intended energy standards.

Inadequate Installations

Autos and appliances are shipped as single, self-contained units, designed to meet certain ratings of efficiency, constructed under stringent factory quality standards with the expectations of operating at or near their value ratings. It is therefore quite likely that a certain automobile, for example, will reach or exceed its EPA-estimated fuel efficiency in real-life conditions. HVAC systems, on the other hand, are not factory-made, self-contained units. It is therefore more difficult to predict how they will function in a given home or business, because of the variety of unique factors that impinge upon a particular system's *actual* efficiency once it is field-installed and combined with a number of highly individual accessories, parts, and on-site conditions.

This report does not claim that the components of HVAC units are not made to high quality standards; in most cases, individual components are indeed engineered and produced according to rigorous standards. But the problem is what happens when large numbers of unassembled parts coming from multiple suppliers are field-assembled by individual contractors, many of who are unschooled in the rigors of factory standards. The installation, or "onsite manufacturing," is an important variable in considering the efficiency of a HVAC system, because how the unit comes together is entirely at the mercy of decisions made by contractors on-site. Unfortunately, many HVAC contractors lack the competency and training to apply factory standards and quality-control on-site. Thus newly-installed systems rarely meet the efficiency levels set by government agencies.

Inadequate Concepts

But it is not the contractors alone who are to blame for the discrepancy between lab-tested SEER ratings and actual, in-home energy efficiency: it is an industry-wide issue. Manufacturers, professional associations, distributors and contractors cling to outdated and inefficient methods. For example, the inclusion of critical chokepoints within the system, which starve the HVAC unit of airflow, is not being addressed, because there is little incentive to do so.

Further, the industry demonstrates little understanding of total system dynamics. That is, they fail to realize that a given HVAC system is not a singular, self-contained unit, but a function of much larger, always evolving architectural context within which it is installed. Changes in the design and building of homes and commercial structures, in other words, change how HVAC systems function within those environments. And within these bigger enclosures are powerful, newly evolved, unseen forces: dynamics relating to the laws of physics, chemistry, airflow, and microbiology. These forces not only affect HVAC operations profoundly, but also the entire indoor environment.

To compound this problem, the individuals and corporations in the HVAC industry also have a vested interest in maintaining the status quo. For example, once business models and engineering strategies in *any* industry are fully organized and implemented, a sense of rigidity sets in to protect these structures and associated philosophies. The HVAC industry is no exception; it is an old-line industry (at over 100 years in age), hedged-in with entrenched concepts and structures with attendant capital structures that make change difficult.

So the idea of possibly correcting millions HVAC units already in place is at the bottom of the pecking order for the industry. Such an idea undermines the rigid business methods and does little to protect billions of dollars of investment in new product. Just as it is difficult to turn a monstrous aircraft carrier around once under "full steam," it is a daunting project to change the mindset of the HVAC industry. Take HVAC contractors, for example. Part of the resistance to upgrade *existing* systems tends to get lost in the business of surviving. For them, generating revenues for *new* or *replacement* units (large ticket items of $3,500 to $8,000 per unit) is about maintaining the viability of the business. Therefore, lower revenue approaches (such as improving existing systems) tend to get lost among more lucrative business strategies.

But the rigidity of business structures, methods and philosophy are not the only reasons for not adapting to new realities. Others include the lack of adequate knowledge, methods and tools to make corrections on existing units or to assemble new systems in a quality, profitable ways.

A Focus on Results

First, the long-term 13+ SEER replacement program does nothing to address the massive energy waste in existing home HVAC units. The energy inefficiency of the existing stock of HVAC systems needs to be addressed first and foremost. Second, under current practices, most newly-installed HVAC units do not match decreed standards. This too must change. If the automobile industry made cars that operated 35% below their intended gas mileage rating, the outcry by government agencies and consumers alike would be loud and clear, and the same accountability ought to be applied to the HVAC industry.

The reality is that the millions of existing HVAC that they represent the largest single waste of energy nationwide. Even though automobiles consume more energy, the discrepancy between *decreed* and *actual* energy efficiency is much greater in the HVAC industry. The fact is that nearly all of the 87 million HVAC units were insufficiently installed, so that they have performed below industry standards, even when newly-installed. And with the average age being 10-12 years, most systems are loaded to the brim with dust and debris, and the problem of energy waste is exacerbated. In short, it's no wonder there is such a massive waste of 64 billion kWh.

A Change of Concept

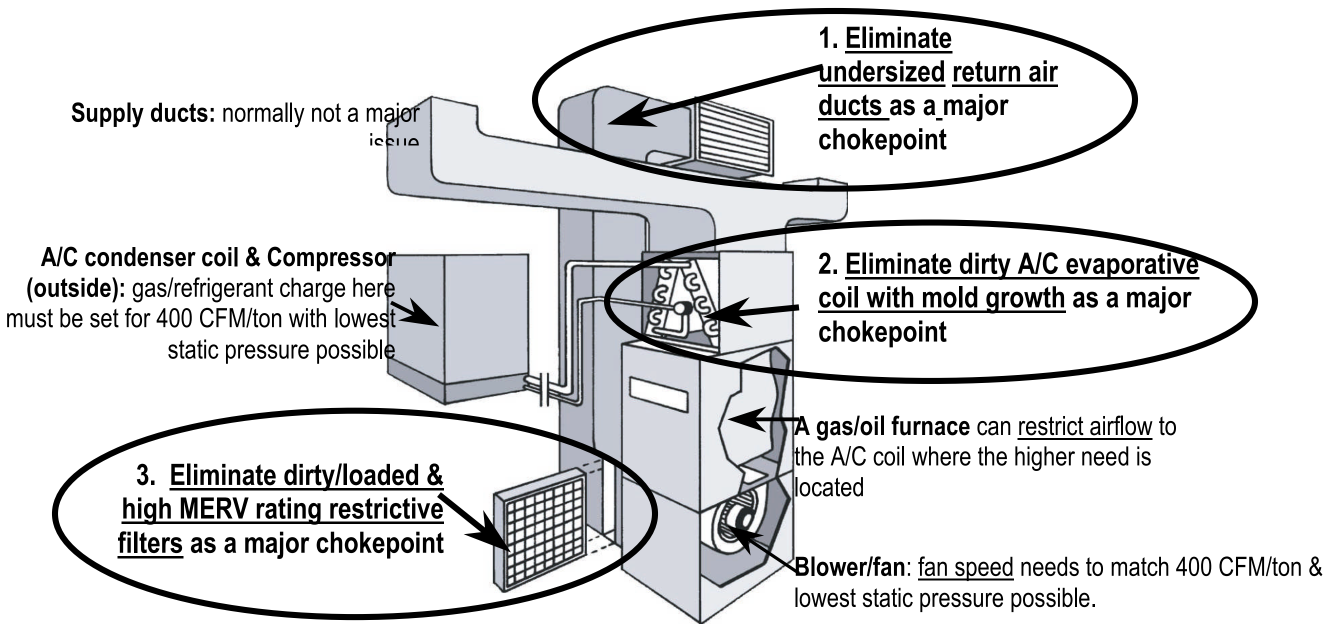
Focusing on the Three Key Components

As already stated, this report is not only about making corrections to three components, although these three components do represent over 95% of the energy problems in most systems. What is needed, and what this report encourages, is a fundamental change in attitude and a shift in the industry's outmoded and unsustainable paradigm. Perhaps the most revolutionary of the advocated attitude adjustments is the way the industry views airflow filters. The recommendation is precisely that the industry should not use the filter at all. Instead, the industry ought to shift its emphasis to making the e-coil self-cleaning. Such an innovation mimics the convenience of other modern household appliances such as self-defrosting freezers and self-cleaning ovens. Furthermore, by getting rid of the filter, much of the airflow restriction caused by undersized returns can be eliminated.

And when these aforementioned changes happen, most of the problems contributing to system inefficiency will disappear. But there is also a need for effective diagnostic tools to verify successful changes, to fine tune, and to reach laboratory-set standards in real-life environments. When these combined changes and testing standards are applied, a jump in system efficiency can be as high as 35 percent.

As suggested earlier, the HVAC system is much larger than just its individual parts. In a sense, the complete system is the building in which it is installed. It therefore follows that the condition of one affects the condition of the other. Therefore, improving the efficiency and quality of the nation's HVAC systems can also improve the quality of indoor environments.

If we are to solve the combined issue of energy waste and pollution sourcing, we cannot be bogged down wading through the whole system mass. We need to focus on the three disruptive components that cause most of the problems: (1) high MERV rated and/or clogged filters, (2) A/C e-coil loaded with debris and mold growth, and (3) undersized return air ducts. These three chokepoints are located, interestingly, within close proximity of one another on the air *return side* of the system. This suggests not spending time navigating through the supply side or the remainder of the system – which will produce few or no results. This understanding is important; the majority of the energy and pollution problems can be solved in the return sector. The following diagram can clarify the location and potential pitfalls of the individual components of a typical HVAC system:



Filter Zone Corrections

Concept of the Filter

Before dealing with the changes to be made in the filter, let's address the current reasons and problems of the HVAC filter. The filter was originally intended to prevent damaging dust collecting on sensitive parts, and fan motor and blades, primarily in the blower housing of the system. Later, when A/C was added, the filter could also capture airborne debris, preventing the obstruction of the evaporator coil (e-coil) as part of the circulating air. Originally HVAC manufacturers would not honor warranties on component parts without the addition of the filter. The initial purpose of the filter, in other words, was to protect equipment.

But beginning in the late 1980s, the filter began to encompass other dimensions as well, namely cleaning the airflow for the breathable space of the building. The idea was to capture the dangerous debris in the circulating air, preventing the inhalation of allergens and dust, thus leading to better overall indoor air quality (IAQ). It was thought this could be done because when the system fan operated, it pulled through a volume of air equal to the 100% of the building every 8-12 minutes. Unfortunately, the industry did not take in a account airflow dynamics: positive and negative air pressures, the Venturi effect which spreads airborne debris, the bio-nesting of mold and bacteria within the system, and the spreading of microorganisms and toxins by the system's fan.

The filter has been a miserable failure at both cleaning the air and preventing dust from collecting on sensitive parts, especially the fans, coils and ducts. The industry responded by introducing new products and services that did little to alleviate the real source of the problem, namely the filter. Suddenly duct cleaning became the new craze. Further attempts were made to upgrade the filter, trying to make it more efficient at capturing debris. To do this, tighter weaves, smaller, even microscopic holes for airflow, were developed. This further evolved into something called "high efficiency filters," or filters with "Minimum Efficiency Reporting Value" or MERV ratings. The electronic, electrostatic, HEPA, ion and catalytic filters started appearing in market offerings.

Problems with the Filter

The objectives of the HVAC filter have never been sufficiently met, regardless of the ways in which the filter was reinvented or repackaged. The whole concept of filter use has to be questioned when it comes to effective operations of the system. In fact, the filter has complicated the problems of dusty, contaminated air, adding to the wear and tear of sensitive parts, spreading contaminates into the living space, and dropping effective operations of the system. Dust and debris still collect on the fan motor, blades, e-coil and ducts, sometimes at even higher levels. The following factors help explain why this is the case.

First, the notion that a fiber material or mesh being less than 1-inch thick can clean thousands of cubic feet of debris-laden air is erroneous. But the problem goes beyond that. The HVAC system contains hundreds of linear feet of ducts, a high-powered fan that sucks air from where ever it can get it (duct holes, for example), plus the entire volume of the house linked to the system by air. To think one can use a 1-inch, or even a 4-inch filter to handle all this is not practical.

As already discussed, indoor contaminates are more concentrated in our homes than even fifty years ago, sealed into the indoor environment of our modern, energy-tight homes. This heavier concentration of polluted particles simply overpowers the HVAC filter. Thus, we need to cast aside the idea that such a minuscule filter zone can do the job. This leads us to the idea that multiple system zones and more powerful concepts must be used to scrub the air clean, and do it with little or no airflow restriction.

Second, we have discussed the idea that the very nature of the filter restricts airflow. This is especially true because of two conditions. First, filters are designed to capture dust, so they load up with debris, making the filter even more restrictive. Since residents rarely clean or replace filters on a timely basis, the system struggles, freezing-up the e-coil and/or causing compressor failure. Second, the industry has a tendency to use high MERV rated filter, further aggravating the problem of starved airflow. These "high-efficiency" filters collect debris faster than even standard filters, accelerating the airflow restriction and energy loss.

Third, the collection of un-cleaned debris embedded in the filter mesh houses thousands of harmful microbial colonies (bacteria and mold). They thrive in this organic debris field, a development called "bio-nesting." Like any organisms, they carry out metabolic processes, but in this case, they produce toxic and noxious gases and waste. Powerful allergens and toxins are generated by molds; certain bacteria are pathogenic. For example, Legionella bacteria, often found in A/C systems (especially at the e-coil), can cause the deadly form of pneumonia known as Legionnaires' disease. Not only do these organisms grow copiously within the system, but also once the system fan is engaged, the microbes with accompanying toxins are fanned into the building's habitable space. In other words, the system filter—intended in part to clean the air of debris—can in fact *pollute* the home with harmful contaminants.

And finally, the growth of molds and bacteria within the filter produce their own debris fields. Thus the growth itself helps to further restrict filter airflow. But it doesn't stop there: with the start of the fan, parts of the debris are pealed off and pulled further into the system, covering the e-coil with a coating of microbial waste and new growth, further restricting airflow there.

Fourth, the fan has been set to pull a given volume of air through the system, based upon the demand of the e-coil at 400 CFM/ton. But in the real world, this volume rarely reaches the e-coil. The fan struggles to carry out its function. Why does it struggle? The HVAC system is not a sealed unit, but is often plagued by numerous holes and cracks along ducts, housings and plenums. This is not necessarily an overwhelming issue, unless the airflow path in the system dusts is partially blocked. As we already know, the use of high MERV rated and/or debris-laden filters restrict airflow. Since airflow takes the path of least resistance, there is a point at which the internal resistance across the filter gets so high, the pulling power of the fan begins "sucking" make-up air from any possible source, including through holes and cracks near the blower fan. The closer the holes are to the fan, the greater the velocity of air speeding through the holes into the system cavity, dragging dirt and debris with it. And of course, this is all done at a point beyond the reach of the filter.

Now we understand, in part, why the internal sensitive parts (such as the e-coil and ducts) are continually covered with debris even in the presence of the filter. It would seem the answer would be to cover holes and seal the ducts, but that is not enough. First, there is no way to do an onsite assembly and have a perfect seal for the system. Keep in mind that when airflow resistance reaches critical mass in the ducts or plenums, the fan struggles to pull the air from any source. For example, one cannot perfectly seal around the door panel joints to the fan housing; there is always a whirlwind of air being pulled into the fan through these joints. Sealing the system is not the total answer, because a perfect seal cannot be realized. The answer is getting rid of the cause for blocking airflow within, which prevents the air from being sucked into the system through the duct channel.

Fifth, the industry concept of filter use is this: the homeowner/resident will clean or replace the filter on a timely basis so the restrictive debris doesn't build up. This simply doesn't happen in the real world. It is estimated that only about 10-12 percent of residents give adequate care and attention to their system filter. In a world with more pressing concerns, few residents remember that there is a filter in the system at all, and fewer still replace these filters on a timely basis.

So with this lack of filters maintenance and replacement, the airflow resistance is continually rising to the point of extraordinary energy use and component failure. Why the industry has kept this idea of the resident end-user making such a valiant and inconvenient effort is a mystery. Or perhaps it can be chalked up to a dogged loyalty to an antiquated concept.

Making a Change - A New Filter Paradigm

Filter locations

A split HVAC system is configured with: (a) the compressor/condenser located outside the home to dissipate the heat generated by compressing gas into a liquid, and (b) the fan, indoor heat source and e-coil are all located indoors, configured around a blower housing attached to return and supply air ducts. So-called "packaged units," on the other hand, contain the condenser/compressor, fan, heat source and e-coil all in one enclosure which is installed outdoors, with ducts feeding indoors for return or supply airflow.

The sequence of assembly between the inside fan, heat source and e-coil depends upon whether a gas/oil furnace is involved. If there is such a furnace, then the progression is (a) fan first, (b) furnace second, and (c) e-coil third (we'll discuss the disadvantage of this sequence later). If there are no such furnaces, but rather electric heat strips, the progression is (a) e-coil first, (b) fan second, and (c) heat strips third.

If the units are heat pumps or geo-thermo, both the cooling and heat source come from the e-coil (reversing refrigerate flow depending on heat or cooling season). In these cases, the alignment is (a) e-coil first, and (b) fan second. The configuration is sequenced with "pull-through" design.

The type of furnace or heat source involved in a unit often dictates the location of the filter in the system. But regardless of the furnace, the filter will always be on the return side of the airflow, upstream from the fan. For systems with gas/oil furnaces, a filter can be at: (a) return air grill (in-house opening for airflow back to the HVAC system); (b) anywhere along the return air duct; or (c) in a filter rack near the fan. This same approach to filter locations also applies to packaged units, except some have filters located in the outdoor, packaged housing.

For systems that are electric heat strips, heat pumps, or geo-thermo units, the filter is usually located just under the "drip pan" attached to the e-coil. As we will discuss later, this arrangement has substantial possibilities in maximizing energy efficiency with the new paradigm.

Making a New Paradigm

One always has to weigh the advantages against the disadvantages for every decision. If the downside overwhelms the upside, whatever is being considered is probably not worthy of consideration. After careful consideration, it becomes clear that current HVAC filtration methods do not measure up. However, the idea of using an HVAC filter to clean the air—preventing particle damage to sensitive system parts, and producing healthy, breathable air—is still a good idea. This is especially true since the system, when operating, circulates a volume of air equal to 100 percent of the total volume of the home every 8-12 minutes. It is the only system within the home that touches almost every molecule of indoor air, and thus is uniquely qualified to carry out this function.

This report does not question the desirability of cleaning the air via the HVAC system, but rather the methods currently employed to do so. Current air filtration methods are draining the efficiency of existing HVAC systems and contributing to increased electrical energy consumption in the home.

This calls for a change in methods used for nearly 100 years – methods that do not function terribly well in the current environment. The change, simply stated, is getting rid of the filter completely. This report suggests that the traditional filter should no longer be part of the HVAC system. But in order to avoid the negative consequences of eliminating the filter, a new method of cleaning the air must be conceived. Such a method should be able to free up airflow (causing little or no resistance as air passes through it), reduce static pressure, and scrub the air to even higher levels of purity.

Force Field Technology

What has to be considered for filter replacement is a concept this report terms a "force field." The filter is a physical thing, something with barriers. To free up airflow and drop internal resistance to HVAC airflow, one must eliminate this physical impediment to airflow, replacing it with an invisible field of energy. A good example of a "force field" is the microwave oven. One cannot see the energy that cooks the food, yet the food gets cooked all the same. Another example is the X ray: invisible electromagnetic energy passing thorough the human body to produce a diagnostic picture. This type of energy (electromagnetic) travels through the air, not limited by some physical dimension – an effective range of up to three, four or five feet. Properly set, whatever task to be accomplished within that energy field is completed.

The return side of the HVAC system contains perhaps the heaviest concentration of airborne dirt, debris and particles in the entire building. Not only does the system foster such contaminants, but also, by virtue of the Venturi Effect, it pulls in debris from the living space of the home at an alarming rate. A powerful device can only eradicate such powerful concentrations of debris.

To keep up with such enormous particle counts and microbial growth, there are several things that should be accomplished in order to rid the system of its debilitating filter. First, there must be effective air cleaning at multiple chokepoints where maximum debris collection and growth occur. There should be multiple cleaning zones up to three-feet in length (not like single ¼ -inch wide filters). Also, the most effective air cleaning will be accomplished with air traveling at a velocity of up to 800 feet per minute. Finally, the concept of particle collection has to change to converting a physical granule to benign atmospheric gases, eliminate the need to capture particles that further restrict airflow.

To accomplish this kind of air and system scrubbing with such high particle counts, and with multiple points and high velocity airflow, the force field technology must carry out multiple processes at high capacities. And this process must be cost-effective in both purchase and energy use, with minimal need for homeowner maintenance.

Everclean Green has developed precisely this type of Force Field technology for use in HVAC systems. To briefly explain, the process uses multiple, invisible electromagnetic energy fields called "broadband." This multi-level energy is not only destructive to microorganisms, toxins and house dust at different wave lengths, but in the presence of a catalyst, certain electromagnetic waves will convert airborne moisture into a very powerful hydroxide molecule, which, in turn, also breaks down contaminates and debris into a benign gas.

The first location in a HVAC unit where a Force Field is to be installed is in the zone formerly holding the filter. But instead of only being a 1-inch mesh, there is an invisible cleaning zone up to two-feet in length that bombards debris laden air speeding along the entire zone. Most debris, especially below .03 microns, is destroyed (converted to a gas) in this zone. Any small amount debris getting by this first zone is assailed further on at a second zone, the e-coil. In other words, much of the length of the system (at key chokepoints) is used to scrub the airflow volume, rather than a single 1- or 4-inch mesh of material.

Benefits of Force Field

Force Field technology overcomes many of the problems associated with the use of filters in HVAC systems.

- Cleans the entire volume of air at several key chokepoints of the system, instead of inefficient filtration at one point, which in many cases may even add contaminants to the air.
- Since there is no physical area for bio-nesting and no particle build-up on a barrier, there is virtually no airflow restriction to the e-coil. Thus the volume of air circulated increases, the needed CFM gets to the e-coil, energy consumption drops, and cooler air circulates in the home from a system that operates much more efficiently.
- Since Force Field technology is destructive to microorganisms, there will be no bionesting. The filter will no longer harbor toxins, allergens and contaminated microbial debris that can be fanned into the breathable airspace.
- Since Force Field technology eliminates the possibility of high MERV-rated chokepoints and debris-laden filter barriers, the path of least resistance is clearly through the return duct. This eliminates the intake of "make-up air" (along with concentrated debris) through holes and cracks near the fan. This helps to prevent damaging dust coating of sensitive parts of system and lowers the food source for bionesting.
- There is no filter that builds up over time with debris that is an inconvenience for homeowners to clean, replace or maintain. This eliminates the real-world problem of too few residents caring for restrictive, dirty or high MERV-rated filters, which is one of the major causes for HVAC energy waste.

When all is said and done, eliminating the filter chokepoint problems benefits the HVAC system in many ways: a major indoor pollution sourcing disappears, and with increased airflow, the efficiency of the e-coil jumps, causing a chain reaction of increased energy efficiency throughout the system. The HVAC system finally has a chance of reaching its intended SEER level of efficiency.

E-Coil Zone Corrections

Problems of the E-Coil

In general, the e-coil is a well-engineered component that meets the objectives of heat transfer and air cooling. But it still has a serious problem, not with design, but with what happens once it starts operating. It is plagued with inadequate airflow and heat exchange levels. It is not the coil itself which is to blame, but various other components in the HVAC system.

The coil is part of a field-assembly of multiple parts. As a result, the coil is affected by forces not often of its own making. Since the e-coil is the hub of the system, it is at the mercy of other components and bionesting processes. Simply stated, the coil often does not get the adequate airflow of 400 cfm.

As we have discussed, the major air blockers that affect the e-coil are:

- Dirty or high MERV-rated filters
- Undersized return-air ducts
- Bionesting in the dark, damp conditions of the e-coil which can grow thousands mold colonies, which, in turn, produce flowing mycelium at a ravenous rate. This runny enzyme floods across the coil leaving a coating that not only restricts airflow, but glazes-over and insulates the fins, preventing ample heat exchange between the airflow and refrigerant.

But there are other barriers and problems affecting coil operations.

- Being third in line for airflow after a gas/oil furnace, the airflow that reaches the coil is lowered.
- Fan speed is often set too low, or there is built-up resistance (from the filter, etc.) which prevents the blower from receiving sufficient air to get air to the coil.
- Gas charge is set far too low or high, causing either inadequate refrigerant levels for effective evaporation or too high liquid refrigerant. Most systems are charged too high.
- Mold growth builds up and clogs the waste-line that drains off water collecting in the drip pan of the coil. When this happens, water overflows the pan, flooding the system cavities and floor or walls of the home.

Force Field at the Coil

The same technology that was suggested to replace the filter all together can also be used at the e-coil, converting the HVAC system to a "self-cleaning" unit. The e-coil is perhaps the best device for filtering the air in the entire system. The reasons for this are: (a) closefitting fins (up to 22 fins per running inch), which capture airborne dust trying to weave its way through these close setting fin plates, and (b) the presence of condensed water on the coil fins which are effective at catching debris. The problem with using the coil as a filter is keeping it clean so there is no deterioration of airflow or heat exchange.

But even if the coil is turned into a self-cleaning unit, we would never recommend that it would be used as the primary air cleaner. With Force Field technology, it can be used as *one* of the major points for scrubbing air, but the principal reasons for converting the coil to self-cleaning are: (a) to destroy the bionesting growth and toxic output that is so abundant at the coil, and (b) to destroy any airborne dust, dirt and debris that collects on the coil fins.

Installing a Force Field at the Coil

Gas/Oil Furnace: with a gas/oil furnace HVAC system, there will be two fundamental Force Field zones: (a) in the old filter area located before the fan, and (b) the e-coil zone, located after the furnace. For all practical purposes, this converts the e-coil into a self-cleaning element. About the only thing that has to be done on a periodic basis is the replacement of the broadband elements about every 3 years.

Even with Force Field technology, and the furnace before the e-coil airflow, the e-coil will still suffer a small amount of restriction because of: (a) the airflow having to weave through the furnace combustion housing, and (b) having a greater distance for air to travel before reaching the e-coil.

Heat Pump, Electric Heat, Geo-Thermal HVAC Units: In these types of systems, the e-coil is first in line for air just before the fan. This arrangement is perhaps the most efficient sequence because the e-coil gets the airflow first, and is not starved for air because of undue distance from the fan and gas/oil furnace restriction (since there is no such furnace in this arrangement).

With the coil being first in line (before the fan), the filter and coil zones can be combined into one "super Force-Field fire zone." This zone is up to 4-feet across, and contains an invisible energy and hydroxide field virtually wiping out all airborne contaminants and destroying any mold or bacteria grow at the coil.

Correcting Undersized Return Air

Problems with Undersizing

Undersized return-air ducts are major chokepoints for airflow through HVAC units. As the designation "undersized" suggests, there is inadequate airflow volume (CFM) into the system, which will result in lower system potential. It is estimated that 60 to 70% of the nation's systems have undersized returns.

However, the major culprit for this issue is the filter and not necessarily the size of the duct itself. That is because the filter, deep in the return, restricts the needed flow of air in the duct to the e-coil. But in doing so, the return is blamed for not being large enough to carry the required air load.

Simply stated, the reason the return is said to be not properly sized is because it is not large enough to overcome the filter's restriction, the limiting factor of airflow. This limitation only gets worse as debris loads up the filter. Further, high MERV-rated, and so-called anti-allergy filters, accelerate the problem by severely restricting airflow even when new and clean.

Correcting Undersized Returns

So what follows is simply this: most, if not all of the "undersized" return problems can be solved by removing the filter and replacing it with Force Field technology. In doing so, up to 95% all systems classified as having undersized returns are corrected. They are now properly sized. There might be rare cases where the return was undersized to such a degree that re-sizing will have to be done even when the filter is replaced by the Force Field, but that would be an exceptional step.

Development of Diagnostic Tools

Lack of Diagnostic Tools

Even though few contractors perform any pressure or airflow tests following installation, some fault has to fall on the lack of availability of sophisticated tools developed for HVAC-specific tests. For example, automobiles are kept at reasonable efficiency through periodic smog, safety, and system diagnosis measurements by the use of such things as dynamometers. Unfortunately, the HVAC industry has no similar process or equivalent diagnostic tool.

Yet by its very nature, the HVAC system (with onsite-assembly) needs even more and better computing devices for compound system diagnostics. There ought to be something to analyze complex on-site variables and bring together an accurate picture of integrated functions that lead to superior system performance. Such a device would not only be useful for initial setup, but also for after-market maintenance.

There are seven key HVAC variables that should be analyzed in order to achieve peak system performance. Those variables are: static pressure, velocity, airflow volume, fan wattage use, condenser wattage use, fan speed, and gas charge levels.

Matrix Green Diagnostic Computer

Where filters have been removed and replaced with the Force Field, the average energy savings for existing HVAC systems was near 21%. When such systems were fine-tuned, using a diagnostic program, there was an additional 10.7% in savings for a total of nearly 32%. When a TXV valve was added (with Force-Field and fine-tuning) to older systems, the savings jumped to 35%.

So the best combination is Force-Field with fine tuning capability. In order to do this, there is a need for a fully-integrated, advanced diagnostic computing tool. Such a tool has finally been developed. Everclean Green is making available to the HVAC market the Matrix Green Diagnostic Computer, for calibrating HVAC operations, integrating a picture of the seven variables previously mentioned. This tool is critical for proper fine-tuning of all HVAC functions.

Furnace & E-Coil Sequencing

Furnace as an Airflow Problem

We can safely say that the change of sequence suggested (i.e. having the gas or oil furnace before the e-coil) flies in the face of firmly-held but antiquated industry beliefs. The sequence of fan, gas/oil furnace and e-coil, is at best disjointed, not living up to good design standards for integrating mechanical and electrical elements, especially with the e-coil perched precariously on top of the fan/furnace housing. This lack of design integration is not the serious issue, but serves to demonstrate how the industry adheres to precedence.

The serious downfall of this setup is the *sequence*, the positioning of the e-coil, which received the airflow last. Why is this a problem? First, the A/C system is the single largest consumer of electrical energy of the HVAC unit. With the quantity of energy used being so high, the majority of waste occurs here. The reason for this is: the e-coil is dependent on a much larger volume of air compared to the furnace. The furnace needs approximately 30-40% less airflow than the e-coil. This is why an HVAC unit has, at minimum, two fan speeds - a higher speed for cooling the air, a lower cycle for the heat season. Requiring less airflow (compared to A/C) means the furnace can be further from the fan than the e-coil. Such an antiquated sequence is like trying to evaporate water from a pot sitting 12 inches from a hot burner. Nothing will happen. But as the pot draws nearer to the burner, minor evaporation can start. Finally, with the pot on top of the burner, there is sustained and effective evaporation of the water.

This same principle applies to the A/C e-coil. Being as close as possible to the maximum heat source results in the most effective evaporation. The closer the e-coil is to the fan, the nearer it is to the highest, effective volume of heat source (air), with the least interference. With the furnace being first in line for airflow, the air has to weave through the guts of the heat chamber before getting to the e-coil. Not only does this build resistance. It also places the e-coil at a greater distance from the heat source. Under such conditions, the fan also struggles to overcome the resistance of distance and furnace.

Change of Furnace Sequence

To reach what would be considered the best sequence for maximum efficiency, future gas/oil furnace-A/C systems being installed should have the e-coil in-line first. This has nothing to do with the millions of current systems already with such furnaces, which would be impractical to change, but with future gains in efficiency as new systems are installed over the next 25 years.

But the industry is not going to make this change without a struggle. Whenever the concept of having the e-coil first in line for airflow is suggested, the industry has this rationale for *not* doing so: if the e-coil is before the furnace, water condensation blows off that coil, coating the furnace combustion chamber/tubes, there to oxidize and rust-out these expensive and critical elements.

What follows is the rebuttal. First, the newer heat tubes are made of high quality carbonate and/or ceramic compounds that are resistant to moisture rusting. Besides, even if these new tubes were not being used, the high temperatures within the combustion tubes themselves are so much more corrosive, more destructive then the small amount of moisture distilling on their surfaces.

But what this argument also suggests is that the industry still looks at the furnace as the priority component in the HVAC system. But consider this: keeping the e-coil located downstream, past the furnace chamber, means extremely hot air (traveling from the furnace) severely corrodes the aluminum fins and copper tubing of the e-coil, damaging the essential functions of this A/C component. This destruction happens to the very element that is the biggest energy-user of the entire system, and therefore ought to remain most efficient.

So the long-term strategy for new units should be to make the pull-through e-coil first in-line, followed by the fan, followed by gas/oil furnaces. This would be a relatively simple engineering change, with a pull-through fan lodged between the coil and furnace. In many ways, the technology for doing this already exists, i.e., HVAC units with electric strips, heat pumps and geothermal units – the coil is already first, followed by the fan. The primary question would then be the best way to mount the gas/oil furnace above the blower housing.

An Integrated HVAC Approach

As we've previously discussed, it will take a whole network to make such nationwide changes. But to do this, there must be a vehicle, a program that takes all the elements needed to accomplish the makeover. That program comes in the form of the HomeGreen.X alliance. This program includes the integration of Force Field technology, Matrix Green Diagnostic Computer program, a national database for home-site energy greening certification (labeling), data/certification sharing with utility companies, ongoing renewal of site certification, and curricula for educating and certifying contractors in "home-greening" steps and process.

1. **HomeGreen.X Schooling:** The key to correcting millions of HVAC systems and upgrading units to higher-efficiency energy levels are local HVAC contractors. In order for them to help make the necessary changes in existing and newly installed systems, they will be schooled in the process for doing so. Correcting erroneous concepts and methods requires significant educational attention. To do this, contractors will attend the HomeGreen.X School for in-depth energy certification. Those contractors attending the school will be issued pocket or shirt patch certificates verifying to the public they are certified in effective energy use skills and indoor pollution control.

2. **Force Field technology:** a description of this process is found on previous pages of this report. But to summarize, Force Field technology is a combination of an invisible energy field of electromagnetic power and hydroxide catalytic reaction, which converts house dust, microorganisms, and toxins into atmospheric gases. This eliminates the need for the HVAC filter with its body of accumulated restrictive, toxic debris. Force Field technology also makes the e-coil self-cleaning. The energy-field process in these two zones frees up substantial airflow, eliminating most, if not all, of the energy waste.

3. **Matrix Green Diagnostic Computer:** This computing device integrates seven variables into a portrait of issues and solutions for fine-tuning the system. Even though there are instruments that specialize in measuring a single HVAC function (such as air pressure, airflow, electric use, gas charge, etc.), the Matrix Green is the first of its kind to integrate all functions into a diagnostic snapshot for fine-tuning the HVAC system, much like the dynamometer for automobiles.

There are some unusual characteristics of the Matrix Green that relate to HVAC: (a) the computing program is the first of its kind to be able to calculate actual real-time energy savings, as well as cooling-load-hours (operating time in a year) and the resulting savings from operating fewer hours; and (b) the computer communicates critical measured data with the True-Energy-Use database, energy site certification, which, in turn, shares this important information with the local utility company for review.

4. **True Energy-Use Database**: To be assured that homes where corrections and upgrades have been made remain at optimal condition, there has to be an element of follow-up and continuity. Automobiles have to be licensed annually, and, in many cases, must be smog and safety certified. There should be a similar type of follow-up for HVAC systems to determine that they are maintaining an acceptable level of energy efficiency. This may eventually lead to HVAC system licensing (labeled with a permanent green certification number, much like car license numbers), once operational corrections are made and energy savings verified**.**

The True Energy-Use Database is the permanent depository of critical site data and measures, verifier of site energy savings, issuer of green license (certification) numbers, periodic verifier of continued energy savings, and the tie-in to the local power utility company for regional energy mapping. This database is key to continued energy site certification follow-up, and to a networking relationship with utility companies for regional energy-use management.

5. **Green Energy Site Certification:** The energy license issued to home HVAC systems is the Green Energy Site Certificate. This numbered certificate label is adhered to the HVAC system, with spaces for recording dates of periodic testing and re-certification. A similar green label is adhered to the front window of the certified home, verifying to the public that the homeowner has proudly met the standards of "greening of the home."

6. **Green Energy Maintenance Agreement:** The certified contractor sets up the semi-annual certifying arrangement (energy licensing), in which every six months the HVAC operations are re-certified by the contractor using both the Matrix Green Diagnostic Computer and the True-Energy-Use Database. The database, in turn notifies the utility company of the continued savings of the certified home for energy-use mapping and possible discounts on kWh for the home remaining energy efficient.