CoolingLogic™: A Brief Summary

Introduction

Several patented and patent-pending technologies, which relate to climate control systems (better known as Heating, Ventilation, and Air Conditioning- HVAC- systems), are collectively referred to as CoolingLogic™. The CoolingLogic™ technologies are capable of reducing the energy consumption of typical 13 SEER HVAC systems to systems attaining efficiencies of 65 SEER. If your unfamiliar with how SEER ratings work, you can think of the ratings as being directly correlated with one another in terms of the SEER rating and how much energy each systems consumes per year. For example: a 2 SEER system uses half of the energy for the same amount of cooling as a 1 SEER system does. Therefore, when we state that the typical 13 SEER system can function as a 65 SEER system, basically we're stating that CoolingLogic™ is capable of providing the same amount of cooling, but only using about one fifth of the energy to do so- in other words, one fifth of the electric bill for cooling. Additionally, CoolingLogic™'s load-shifting technology has very significant implications for peak-load electricity consumption over wide regional areas and for electricity providers.

CoolingLogic™ incorporates methods of operating Heating, Ventilation and Air Conditioning (HVAC) systems, that can be compared to artificial intelligence for HVAC systems. It is our hope that this brief summary will provide a quick and easy overview of some of the sophisticated and mathematically complex algorithms and processes that make up CoolingLogic™.

It's important to note that while this summary focuses on certain aspects of the CoolingLogic™ technologies, it certainly does not cover all aspects of the technologies. If you would like a more complete disclosure of the technologies, please start by visiting www.CoolingLogic.com. For a complete disclosure or for any questions which you may have, please give us a call- we would be happy to discuss the matters with you. Thank you for your time and consideration and I hope that you enjoy the information!

Overview of CoolingLogic™

One method of CoolingLogic™ is to utilize mathematically calculated heat transfer "metrics", based on historical and input data, in order to predict the next period's (i.e. the next day's) heating or cooling energy required. This is accomplished using complex algorithms which predict:

1. The next day's average space temperature → Predicted Average Space Temperature (PAST).

2. The amount of heat energy that the HVAC systems will need to transfer (or produce) for the next day → NTotal_heat_transferred.
3. The optimal time period(s) during the next day to cool or heat the structure, when the outdoor air is most suitable (causing the HVAC system to operate proactively instead of reactively).
4. Properties of the structure and its components, including a thermal capacity metric. This is done automatically- without user input.

The process then heats or cools the structure, using either outdoor air alone, or mechanical methods, at the optimal time of day. The structure retains the “hot” or “cold” depending on it’s thermal capacity and system operation. Hence, less/no heating or cooling is needed at non-optimal times of the day (such as the heat of the day), when it would be more expensive to run HVAC equipment, and energy costs are greatly reduced.

As we have calculated, a typical big-box store such as Home Depot could save between 30% and 80% in energy costs if CoolingLogic™ were in use (dependent on many factors).

Benefits of CoolingLogic™

An easy way to understand CoolingLogic™ is to think of the term “load-shifting.” Essentially, CoolingLogic™ shifts the cooling operation of HVAC systems from the heat of the day to a time when transferring energy is significantly less expensive. Outdoor air temperatures go up and down, typically directly correlated with the intensity of sun-light on that region of the earth; up after dawn, and down after the heat of the day (usually around 3:00 pm). This is a pretty reliable occurrence. Typical HVAC system operation is reactive, meaning that when the indoor air temperature goes up, the A/C comes on. It’s easy enough to understand that as it gets hotter and hotter outside, the A/C runs more and more to maintain set point. CoolingLogic™ is proactive instead of reactive; meaning that instead of waiting for the outdoor air temperature to go up before cooling, it will cool during the coolest part of the day - when it is much less expensive. Additionally, CoolingLogic™ utilizes the thermal capacity of the structure (and the materials inside the structure) to “store” cool air.

Frequently Asked Questions

1. What about humidity?
   - Humidity is not a problem, but rather a good thing. As the outdoor air with higher relative humidity (RH) is injected into the building and is heated by the materials and things inside the structure, the RH of that same air drops as it increases in temperature.
   - Air with higher RH increases the thermal heat transfer coefficient of the air, so cool air with higher RH feels “cooler” than dry air of the same temperature.

- Cooling with outdoor air does not cause condensation inside the structure.
- HVAC equipment doesn't need to dehumidify the air because CoolingLoigc™ almost perfectly predicts the amount of energy needed to heat of cool the structure - meaning (typically) no "conventional" heating or refrigerant-based cooling is needed. If the conventional, refrigerant based A/C doesn't come on, then the HVAC system(s) will not be dehumidifying the air.

2. Don't the occupants of the structure get too cold?
   - No, limits can prevent over-cooling, however, in many cases the limits will never even be reached.
   - Take a really close look at the space temperature of the below graph showing CoolingLogic™ in operation You'll notice that the temperature only drops by 1.1^{o}F after the structure reaches equilibrium, but also before the building becomes occupied- that's enough pre-cooling to avoid mechanical cooling for an entire day in this case.

3. What if it's not cool enough outside to use outdoor air to cool?
   - In almost every location world-wide, there is usually some time when outdoor air can be used to cool, the seasons for doing so simply get pushed closer to the winter the closer to the equator one gets.
   - The hottest months of the year in Michigan have an average low of around 63^{o}F - which is plenty cool enough to use the technology.
   - Even if ventilating with outdoor air is not a suitable solution for cooling, systems can still obtain savings of around 30% by using mechanical cooling during the coolest part of the day.

The graphs below show relationships between the values of outdoor air temperature (ODAT), space temperature (ST), elevated ST, the energy transfer metric, and the Energy Efficiency Ratio (EER). It's important to note that we have been very conservative with our numbers. Some of the data is real, and other data is calculated/estimated using mathematical modeling, laws of physics (Newton's law of Cooling), etc. The graphs which do not show CoolingLogic™ incorporated into the systems are pretty much "best case scenarios" of what one might hope to find. Basically those "best case scenarios" are usually never evident in real life scenarios. Conversely, the graph for the CoolingLogic™ scenario is not a best case scenario. The CoolingLogic™ graph does not factor in "typical" roof-mounted exhaust systems, which typically have a much lower differential static pressure and may be twice as efficient as a typical ducted roof-mounted packaged HVAC unit, which is the basis for these calculations. Often times, roof-mounted exhaust fans would also be incorporated to encourage the transfer of air and significantly lower the cost to do so. This added benefit would cause CoolingLogic™'s efficiencies to increase even more.

As demonstrated by the figures below, the EER is greatly increased when CoolingLogic™ is used.

Figure 1: Typical System with no inefficiencies, without CoolingLogic, and using Y2 --- Calculated EER = 15.0

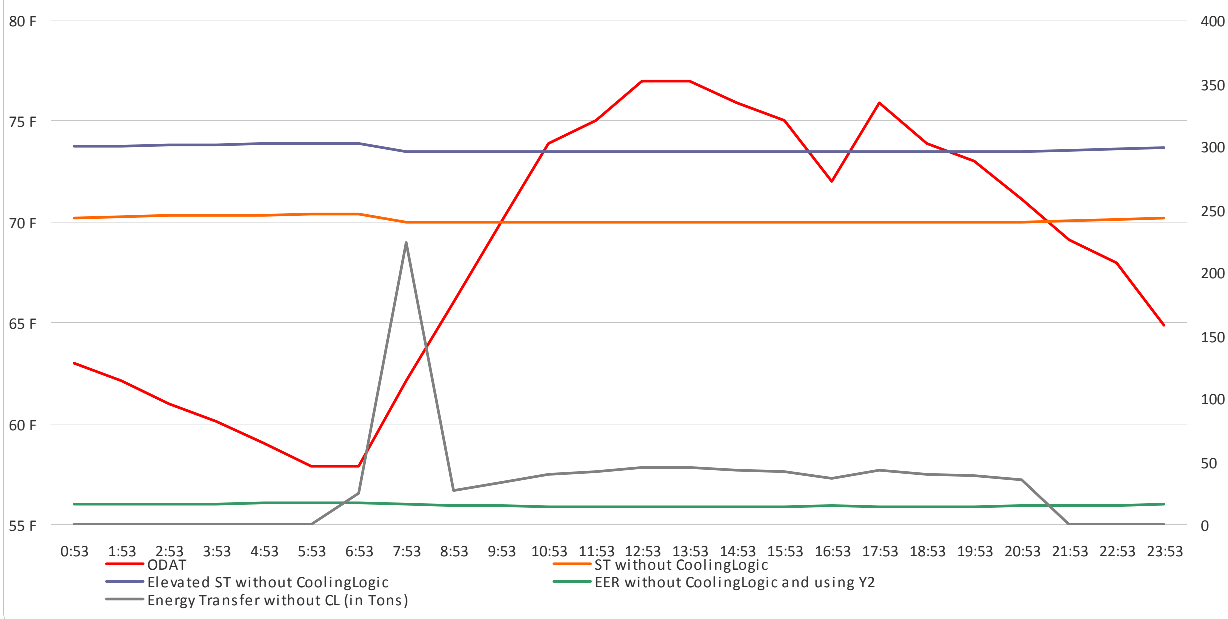
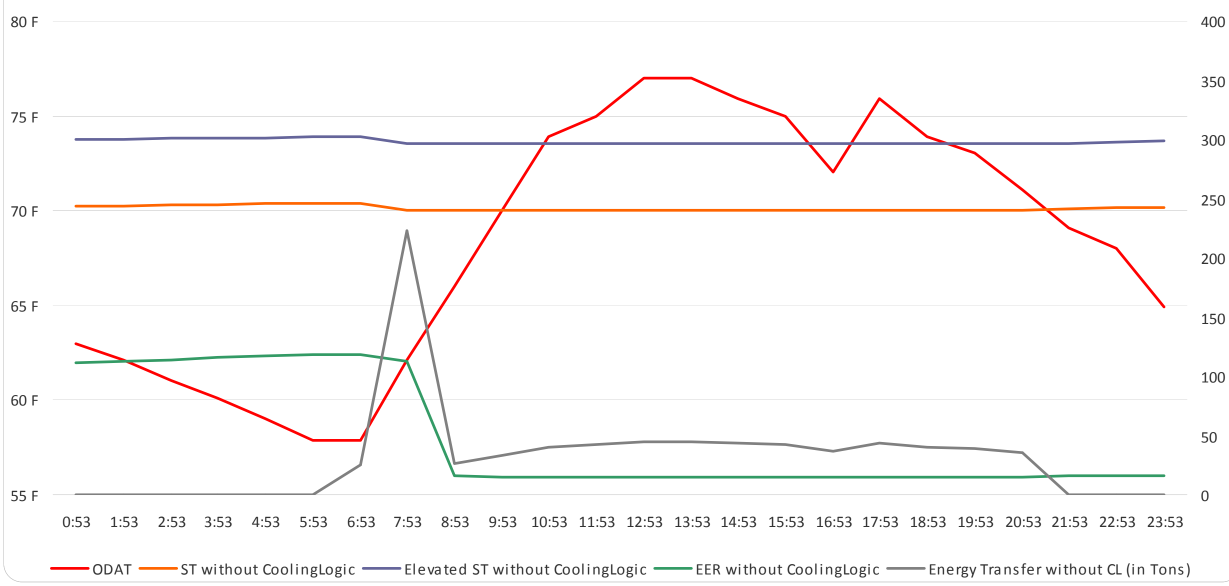
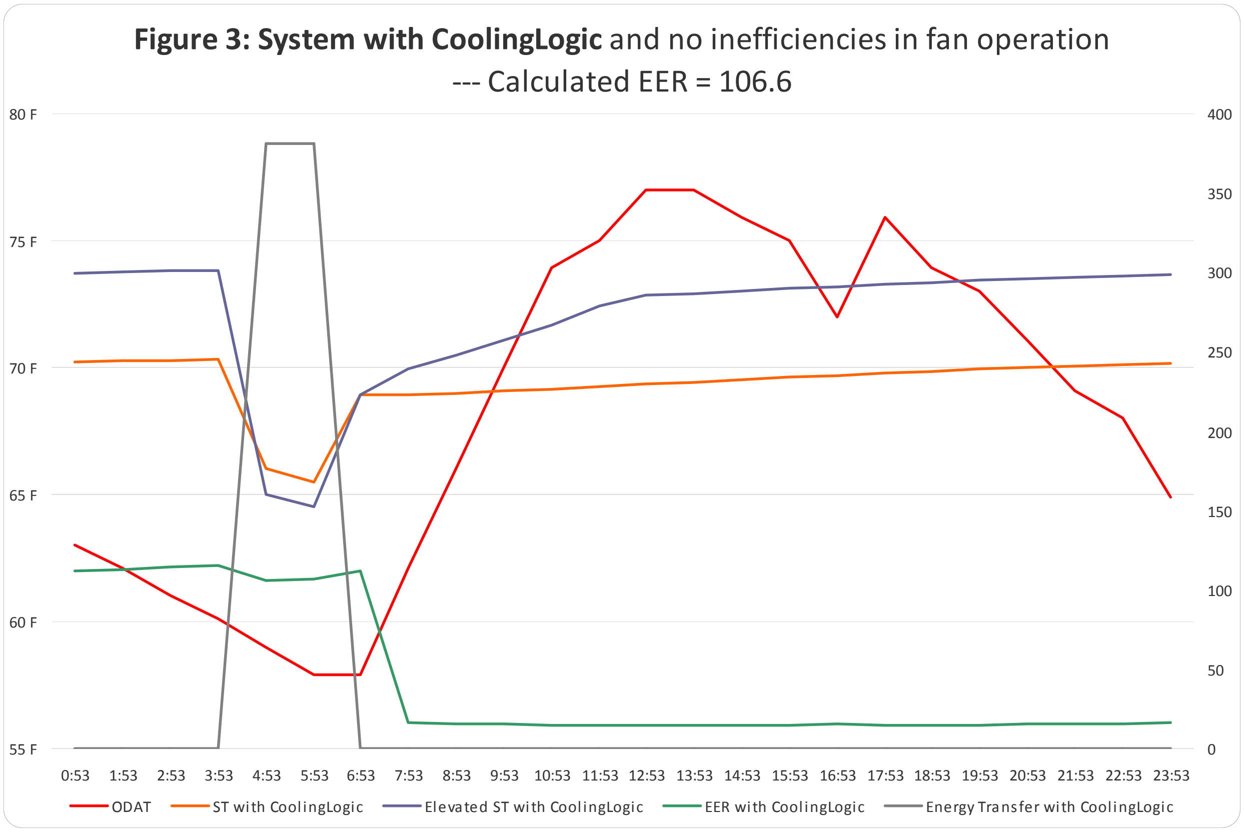


Figure 2: System with "high efficiency" control scheme, no inefficiencies, and no CoolingLogic (allowing for ODA ecconomization and not using Y2)--- Calculated EER = 47.1





If you are interested in obtaining the original file used to create the above charts, with the equations (and values) embedded, those can be provided.

Financial, Energy, Statistical, and Data Tables

The two tables below show the savings that could be realized using CoolingLogic™ in the residential and commercial market, respectively.

While reviewing the total annual savings offered by CoolingLogic™, please understand that the average square-footage of the typical commercial building used in the calculations is set to 15,536 square feet. This is a very important consideration because many commercial structures have much greater square footage than 15,536 square feet, and therefore larger savings could be realized.

Residential Sector	Georgia (Atlanta)	Michigan (Detroit)	Nevada (Las Vegas)	New York (New York)
State Population [14]	10,214,860	9,922,576	2,890,845	19,795,791
Total Residential KW [9]	57,178,165,790	33,527,330,428	11,927,992,556	49,968,617,464
Single dwelling structures (typical homes) [12]	2,107,317	2,988,818	432,437	3,198,486
Single dwelling structures KW	23,510	9,849	21,145	10,650
Multi-dwelling structures and mobile homes [12]	974,420	1,245,461	395,020	4,480,821
Multi-dwelling structures KW	7,837	3,283	7,048	3,550
Price per KW [17]	$0.1164	$0.1446	$0.1293	$0.2007
Total annual electricity costs (single dwelling structures only)	$2,736.56	$1,424.23	$2,734.05	$2,137.46
% of electricity due to A/C [10]	48%	48%	48%	48%
Annual electricity costs due to A/C (single dwelling structures only)	$1,313.55	$683.63	$1,312.34	$1,025.98
Estimated reduction in A/C electricity consumption due to CoolingLogic™ (single dwelling structures only)	30%-80% Configuration dependent	30%-80% Configuration dependent	30%-80% Configuration dependent	30%-80% Configuration dependent
Annual electricity costs saved due to CoolingLogic™ (single dwelling structures only)	$394.07 - $1,050.84 Configuration dependent	$205.09 - $546.90 Configuration dependent	$393.70 – $1,049.88 Configuration dependent	$307.79 – $820.78 Configuration dependent
Annual repair costs saved due to CoolingLogic™ (single dwelling structures only)	$50 +/-	$50 +/-	$50 +/-	$50 +/-
Annual amortized life-cycle value saved due to CoolingLogic™ (single dwelling structures only)	$50 +/-	$50 +/-	$50 +/-	$50 +/-
Annual total estimated / calculated savings due to CoolingLogic™ (single dwelling structures - "typical home")	**$497.07 - $1,150.84**	**$305.09 - $646.90**	**$493.70 - $1,149.88**	**$407.79 - $920.78**

The proportion of KW per home is different for single-dwelling structures than it is for multi-dwelling structures. The factor used is that single dwelling structures are attributed three times the energy consumption of multi-dwelling structures, per dwelling. For example; one single dwelling structure, in these calculations, is attributed an energy consumption which is equal to three multi-dwelling structures. The base-line reference of energy per dwelling was derived from the United States Census Bureau's report on the number and types of dwellings [12], and also a U.S. Energy Information Administration report on the amount of electrical energy used in the residential sector per State [9].

According to Energy.gov, approximately 48% of residential energy consumption is due to heating and cooling systems [10]. Since not every residence in the U.S. has central air conditioning, and since the term "energy consumption" is seemingly inappropriate, since electricity costs exceed that of natural gas in many areas, it seems reasonable to use 48% as a conservative baseline for residential electricity consumption due to air conditioning.

To find the energy per single dwelling structure, and per multi-dwelling structure, the following is used, respectively; $E1 = T / (S + 1/3 * M)$; $E2 = T / (3 * S + M)$; Where, E1 = energy per single dwelling structure, E2 = energy per multi-dwelling structure, T = total energy, S = number of single dwelling structures, M = number of multiple dwelling structures.

Commercial Sector	Georgia (Atlanta)	Michigan (Detroit)	Nevada (Las Vegas)	New York (New York)
State population [14]	10,214,860 (3.18%)	9,922,576 (3.09%)	2,890,845 (0.90%)	19,795,791 (6.16%)
Total commercial annual KW [15]	46,598,300,157	37,337,254,340	9,407,581,353	76,550,163,529
Total number of commercial structures per state [13]	177,971	172,879	50,366	344,897
Annual KW per Commercial structure	261,831	215,973	186,784	221951
Total Commercial Square footage State-wide [13]	2,764,906,607	2,685,848,144	782,486,176	5,358,319,792
Average square footage per structure	15,536	15,536	15,536	15,536
Electricity per square foot KW	16.85	13.90	12.02	14.29
Price per KW [18]	0.1036	0.1087	0.0947	0.1614
Total annual electricity costs (per average commercial structure)	$27,125.69	$29,299.32	$17,688.48	$21,806.43
% of electricity due to A/C	48%	48%	48%	48%
Electricity costs due to A/C (per average commercial structure)	$13,020.33	$11,268.62	$8,490.47	$17,194.97
Estimated reduction in A/C electricity consumption due to CoolingLogic™ (per average commercial structure)	30%-80% Configuration dependent	30%-80% Configuration dependent	30%-80% Configuration dependent	30%-80% Configuration dependent
Annual electricity costs saved due to CoolingLogic™ (per average commercial structure)	$3,906.10- $10,416.26 Configuration dependent	$3,380.59- $9,014.90 Configuration dependent	$2,547.14 - $6,792.38 Configuration dependent	$5,158.49 - $13,755.98 Configuration dependent
Total # of 10 ton cooling systems	4	4	4	4
Square feet per ton (approximate)	388	388	388	388
Annual repair costs saved due to CoolingLogic™ (per average commercial structure)	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00
Amortized life-cycle value saved due to CoolingLogic™ (per average commercial structure)	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00	$100 +/- per unit = $400.00
Annual total estimated / calculated savings due to CoolingLogic™ per sq. ft. (per average commercial structure)	**$0.30 - $0.72**	**$0.27 - $0.63**	**$0.22 - $0.49**	**$0.38 - $0.94**
Annual total estimated / calculated savings due to CoolingLogic™ (per average commercial structure)	**$4,706.10 - $11,216.26**	**$4,180.59 - $9,814.90**	**$3,347.14 - $7,592.38**	**$5,958.49 - $14,555.98**

Data on commercial buildings per State was difficult to find. Such as this is the case, we've based our calculations on the national averages divided by State population to derive the number of commercial buildings per State. Likewise, we've used national averages of square footage to determine our calculations. According to statistical data [13], the national average square footage of a commercial building is equal to 15,536 sq. ft., when the total square footage of commercial floor space is divided by the total number of commercial buildings. We used 10 ton HVAC systems as a baseline, since some buildings will have larger capacity systems and some will have smaller capacity systems.

Conclusion

Many traditional schools of thought or preconceived notions of industry professionals may have been broken or redirected by the CoolingLogic™ technologies and the documentation pertaining to the technologies. Humidity, traditionally seen as an energy drainer by professionals in the refrigeration industry, may now be seen as an ally to saving energy. Additionally, humidity during the cooling season, which has traditionally been seen as a bad thing (concerning human factor considerations) may now be seen as a good thing. Perspectives on thermal capacities of many may shift from simply considering the air to now considering all matter inside the structure's outer-most boundaries. Also, the term "thermal heat transfer coefficient" will likely be the subject of many more conversations. As in life, when thoughtful consideration is given to a matter before a decision is due, it's likely that the outcome will be more desirable. CoolingLogic™ saves energy because it transfers precisely the right amount of energy, at precisely the right time, and uses precisely the best mode of energy transfer to do so.

CoolingLogic™ offers additional benefit in terms of "reducing the links in the chain" of the things which must operate efficiently for systems to attain the highest possible transmission of heat energy. An HVAC system rarely operates at the listed performance of the system because there are many components to HVAC systems whose single inefficiency in operation affects the total efficiency of the system as a whole. For example: coils may become loaded, refrigerant charges may be less than optimal, and motors may have failed. Inherently, CoolingLogic™ is significantly advantageous in maintaining extremely high levels of operation with only few components affecting efficiency when compared to conventional refrigerant based cooling methods. CoolingLogic™ reduces energy consumption, reduces wear and tear on HVAC equipment, increases the life-span of HVAC equipment, reduces repair expenses, reduces service expenses, and has many other considerations of consequence. CoolingLogic™ increases indoor air quality significantly, in many cases, because it may "flush" a structure with outdoor air, thereby reducing CO_2 and hazardous VOC's in the indoor air.

For energy providers: in the future years CoolingLogic™ will play a significant role in both reducing load demands and in reducing peak load demands in their service area.

Disclaimer

This document has been produced and provided to you with the intention of showing the benefit of CoolingLogic™. This document has been prepared in good faith; however, we take no responsibility for anything contained in this document which may be factually incorrect. This document is not to be used to make any financial or business decisions.

About the Charts

Using the example structure given in the white paper for CoolingLogic™, it's reasonable to assume that a big-box store (i.e. Home Depot) may have a thermal capacity of around 500 tons/degree. Also, using the rate of temperature change calculations given in the white paper for CoolingLogic™, it can be calculated that such a structure would have a heat absorption (due to the intake of outdoor air and also due to conduction) of 1.681 tons/hr/degree in difference in temperature between YODAT (a variable from the first CIP of CoolingLogic™) and space temperature (ST).

For our calculations we used the AB (a variable from the first CIP of CoolingLogic™) derived from a field installed system at a building in downtown Detroit. The Structure had an AB of around -23 degrees F. In many respects the structure used to obtain AB was a very poor choice because 1) it has no insulation in it's walls or it's ceiling, 2) it does not directly intake outdoor air and 3) it's IHEPIS (a variable from the first CIP of CoolingLogic™) was pretty low. At this time we do not have enough data to confidently provide a "typical" AB value, however, the AB of this building is -23, so we've rounded to make the math a little easier and we've used an AB of -20 in our calculations. While this value may have error, I can say that it does seem reasonable/conservative considering that I've seen other structures with much lower AB values. All in all, I consider -20 to be a reasonable/conservative AB value. For the energy efficiency ratio (EER) of the HVAC systems we used a value/rating of 14. Why it's almost certain that your lost at this point, I'll simply state that we've used very conservative numbers.

Referenced data and equations can be found in the CoolingLogic™ White Paper, and in the patent Continuation In Part (CIP) which are on our website www.CoolingLogic.com..