

ELECTRICAL ENERGY REDUCTION IN REFRIGERATION AND AIR CONDITIONING

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1. INTRODUCTION

In the coming decades, actions to limit greenhouse gas emissions could affect patterns of energy use around the world and alter the level and composition of energy-related carbon dioxide emissions by energy source.

Carbon dioxide is one of the most prevalent greenhouse gases in the atmosphere. Anthropogenic (human-caused) emissions of carbon dioxide result primarily from the combustion of fossil fuels for energy, and as a result world energy use has emerged at the center of the climate change debate.

2. CARBON DIOXIDE EMISSIONS

The U.S. Energy Information Authority projects that world carbon dioxide emissions will increase from 25,028 million metric tons in 2003 to 33,663 million metric tons in 2015 and 43,676 million metric tons in 2030. Much of the growth occurring in Asia (see Figure 1 & 2).

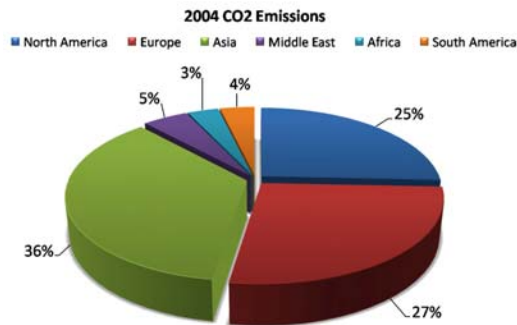


Figure 1: Worldwide Carbon Dioxide Emissions 2004

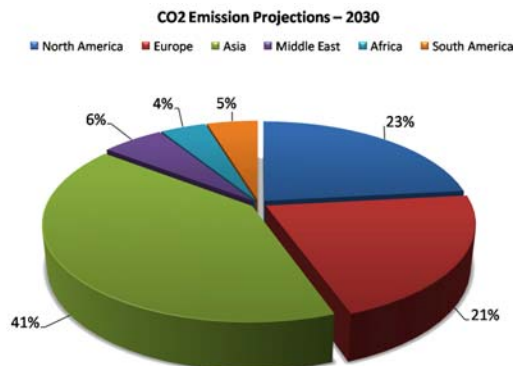


Figure 2: Projected Worldwide Carbon Dioxide Emissions 2030

When most people consider carbon dioxide emissions, they think of large factories, forms of transportation and burning both man made and through forest fires.

Most people would be surprised to learn that electricity actually causes more carbon dioxide emissions than all other anthropogenic sources;

According to the Energy Industry Administration in the United States, electricity generates 39% of the total anthropogenic carbon dioxide emissions.

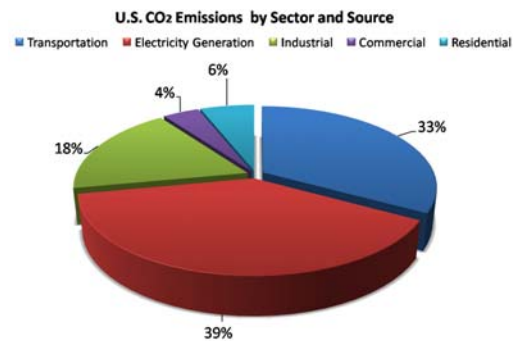


Figure 3: Carbon Dioxide by Sector and Source 2005

These emissions are expected to grow by almost 45% over the next 25 years and grow to 42% of the total carbon dioxide emissions.

3. GREENHOUSE GAS REDUCTION

In order to reduce the production of greenhouse gases, it is reasonable to assume that we should focus on the reduction of emissions in both electricity and transportation.

As most people are aware, the result of continuing and increasing pressure from geo-political events, environmental lobby groups and governments around the world is an accelerating global demand to reduce the dependence on fossil-fueled electricity. International treaties such as the 'Kyoto Accord' have resulted in many countries formally committing to significantly reduce green house gas emissions. Even countries such as the United States that have not formally signed onto the 'Kyoto Accord' have introduced their own plans to aggressively reduce 'green house gas' emissions. Recent geo-political instability in major fossil fuel-producing regions has only served to increase public demand to reduce dependence on fossil-fueled electricity.

4. ENERGY USAGE

What makes this a bigger challenge than most would think is that our dependence on energy is increasing. World energy consumption is projected to increase by 71 percent from 2003 to 2030. Fossil fuels continue to supply much of the energy used worldwide, and oil remains the dominant energy source.

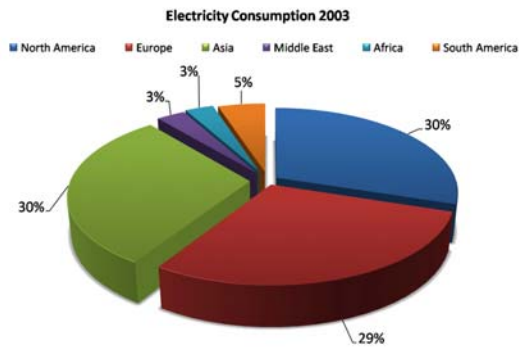


Figure 4: Worldwide Electricity Consumption 2003

Trends in end-use sector energy consumption can vary widely, according to the level and pace of economic development in a given region. On a worldwide basis, energy demand in the industrial sector grows most rapidly, at an average rate of 2.4 percent per year. Slower growth is projected for the buildings sectors: residential energy use rises by an average of 1.7 percent per year and commercial energy use by 1.8 percent per year from 2003 to 2030 for the world as a whole.

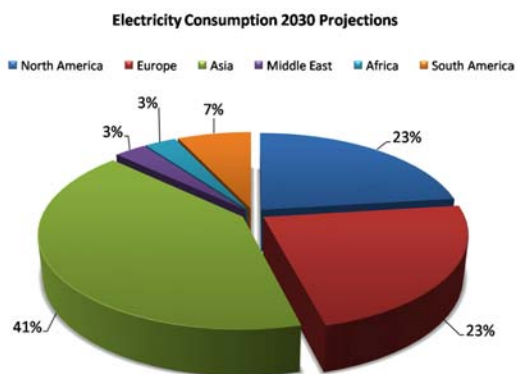


Figure 5: Worldwide Electricity Consumption 2030

All of this is surprising when you consider the efforts to reduce greenhouse gases will require the reduction of emissions caused by them.

5. ELECTRICITY USE REDUCTION

There are two ways to reduce the emissions caused by electricity. The first would be to use more renewable energy sources like wind and solar power. The second is to reduce the amount of electricity we are using around the world.

According to the US Department of Energy, the largest single use for electricity is lighting (27%) followed by cooling (refrigeration and air conditioning) at 15%. In countries with higher ambient temperatures, the usage in air conditioning will be significantly higher, likely coming much closer to the percentage represented by lighting in the U.S.

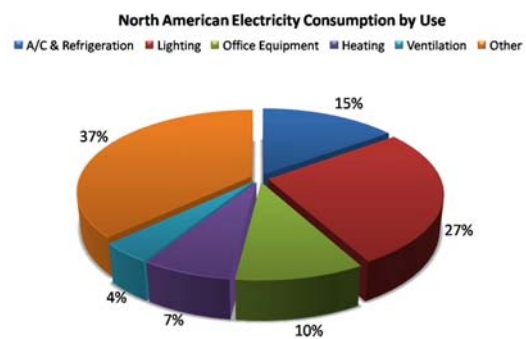


Figure 6: North American Electricity Consumption by Use 2005

There has been a great deal of development in the lighting field to reduce energy, however, in the area of A/C and Refrigeration, most of the development has resulted in expensive and complex systems requiring highly skilled installers and programmers. The cost of these systems prohibited the installation by most small to medium consumers and even larger businesses have been challenged to justify the expense.

6. AIR CONDITIONING & REFRIGERATION CHALLENGE

In air conditioning and refrigeration systems, the compressor is the largest consumer of electricity, in most cases consuming about 70% of the total electricity. Reducing the amount of time the compressor runs will substantially reduce the amount of energy used.

The refrigeration cycle is dynamic and changing. From the time the compressor commences to run until it stops, the suction pressure, evaporator temperature, the rate of heat exchange, refrigerant flow, and many other factors are continuously changing. The total efficiency of the system changes through the entire life cycle.

The majority of modern controls concentrate on the conditioned space temperature, the chilled water temperature or suction pressure. The compressors

are switched on in a response to call for cooling and will operate until that demand for cooling is satisfied. To avoid rapidly and repeatedly switching the compressors on and off (short cycling) which will cause damage to the compressors, the control bands are usually set with a minimum differential of approximately 4 PSI or 5°C. In many cases the compressor control differential is greater than this.

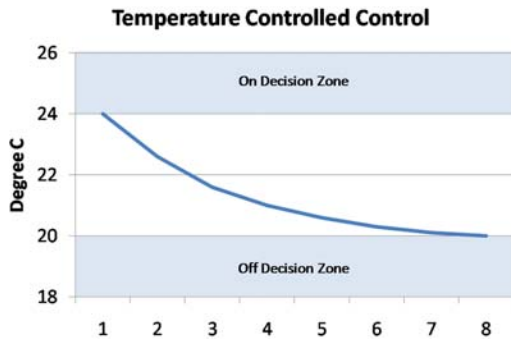


Figure 7: Modern Refrigeration Control Band

The compressors capacity to remove heat is directly proportional to the operating temperature. That is, the higher the controlled temperature, the higher the suction temperature (evaporator temperature), the faster the rate of heat removal.

For example, Figure 8 shows the compressor cooling capacity at each degree of suction temperature to reduce the temperature from 10° to 5°.

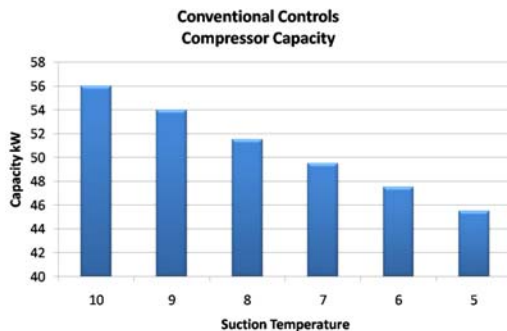


Figure 8: Compressor Cooling Capacity Over Suction Temperature

When the compressor first starts at the high limit point it will be operating at maximum efficiency with a high suction pressure. As the conditioned space temperature is reduced, the suction pressure reduces and compressor capacity is reduced. Therefore each degree of temperature reduction takes a longer period of time and uses substantially more electricity.

Table 1: Capacity, Time & Energy for Nominal 40 kW Heat Load

Temperature °C	Cooling Capacity kW	Motor kW	Minutes/°C	kWh/°C
10	56	16.6	0	0
9	54	18.4	6.6	1.84
8	51.6	16.2	7.56	2.05
7	49.7	16.0	9.16	2.45
6	47.7	15.8	11.03	2.91
5	45.5	15.3	14.4	3.57
		Total	48.77	12.82

Looking at the example in Table 1, Reducing from 10° to 9° takes only 6.6 minutes and 1.84 kWh.

Reducing from 6° to 5° takes 14.4 minutes and 3.57 kWh.

The last degree of pull down used almost twice the energy and time.

This example uses only a +/- 2.5°C suction temperature differential. Even with this small control band there is a significant difference in energy consumption between the first one-degree reduction and the last one-degree reduction.

Figure 9 illustrates the percentage of energy used per degree. The last degree of pull down used 28% of the total energy for the cycle.

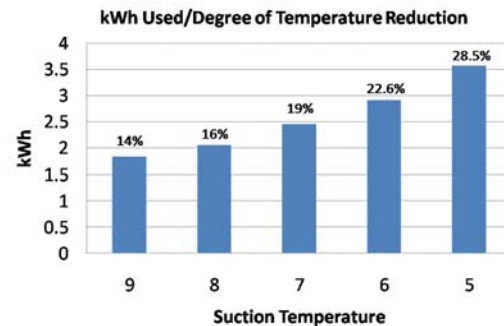


Figure 9: Energy Used During Each Degree of Cooling

Eliminating the last degree, that is start at 10°C and stop at 6°C providing a differential of 4°C, reduces energy consumption by 28%.

Unfortunately this increases the mid point temperature from 7.5°C to 8.0°C.

7. AIR CONDITIONING & REFRIGERATION SOLUTION

Smartcool Systems Inc. is an advanced energy conservation solutions company that specializes in energy and cost reduction technologies for commercial and retail businesses. The company's wholly owned subsidiary, Smartcool International

Inc., is the owner, developer, manufacturer and worldwide distributor of the Energy Saving Module (ESM)TM.

The Energy Saving Module System 4000TM is designed specifically to reduce the electricity consumption (kwh) and maximum demand (Kw/KVA) of refrigeration and air conditioning compressors by improving their performance and maintaining temperature control.

The Energy Saving ModulesTM are designed to interface with all types and makes of air conditioning and refrigeration controllers from the simple thermostat single condensing systems to the most sophisticated computer based multiple compressor parallel systems.

The Energy Savings Module System 4000TM is not a controller. It is a supplement to the existing system - designed to work with the existing A/C and Refrigeration equipment along with current control methodology - to reduce the consumption of energy. When a call for cooling comes from the existing control the ESM 4000TM takes over to determine when and for how long each compressor or unloader will run.

Because the primary control is not replaced, at any time, the ESM 4000TM can be put into bypass and the system returns to operating exactly as it was prior to the installation. This is an important distinction for system repairs and/or troubleshooting.

The ESM System 4000TM enables the compressor to maximize the rate of heat removal by optimizing the natural physical properties of the compressor operating cycle. This process, known as “Compressor Optimization” can reduce compressor running time by up to 30% with no affect on the temperature conditions.

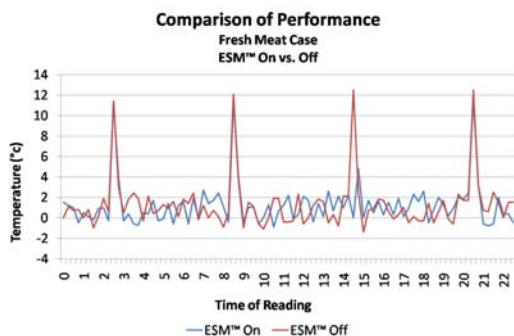


Figure 10: Comparison of Controlled Space Temperature in Refrigeration System

Figure 10 demonstrates how the ESMTM has no appreciable impact on the controlled space temperature. Many other technologies like floating setpoint will impact the temperature.

Through the use of copyright software, the ESMTM manages the suction pressure of the refrigeration or air conditioning system in order to cool more efficiently. This is illustrated in figure 11.

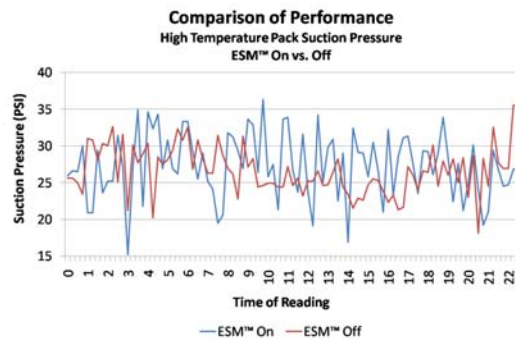


Figure 11: Comparison of Suction Pressure in Refrigeration System

By controlling the suction temperature or pressure over a narrow band, it is possible to maximize the compressor performance, increase cooling capacity by as much as 30% and achieving compressor optimization.

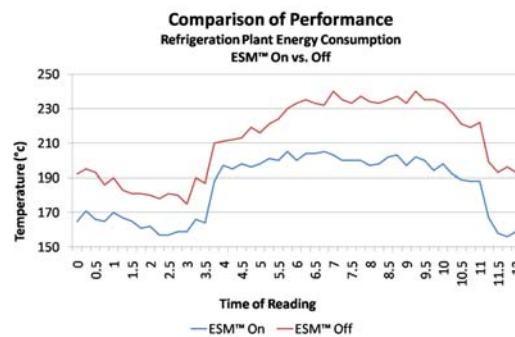


Figure 12: Comparison of kW Demand in Refrigeration System

Having two modes, the ESM System 4000TM can operate in Simplex for single compressor applications and in Multiplex for multi-compressor parallel racks and packaged units. Additionally, through our intelligent interface module, even the most complex chiller packages can benefit from the implementation of the ESMTM.

In March of 1998, the Los Angeles Department of Water & Power conducted a study of the Smartcool product in a live field test. The results were that: the average kWh saving, for comparable days, is in the range of 20 to 24 percent; the unit is capable of reducing the operating time of the compressors of the refrigeration system, which reduces the energy consumption of the compressors and saves electric billing dollars; and the compressors were turned on and turned off more often during the “ON” time when the is in saving mode. The number of cycles per hour was registered at 3 to 4 cycles per hour, which is in the safe range of cycles for a compressor.

Oakridge National Labs which is part of the U.S. Department of Energy conducted several studies of the ESM™ during 2004. The results were indicated to be the reduction of compressor kWh usage of 11.87% for total test period and 18.1% for high load test period.

Smartcool's services are utilised by some of the worlds leading corporations particularly in the commercial, retail and food service areas.

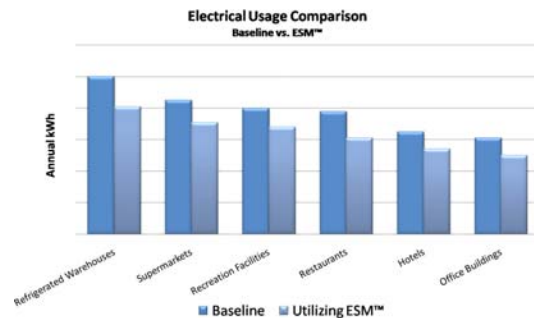


Figure 13: Savings Achieved Using ESM™ By Market Type

A test initiated by Tesco UK, where two stores were tested for a 4 week period, resulted in between 17 and 21% energy reduction. Tesco concluded that: the ESM™ has again proven substantial energy savings under test conditions and will deliver a return on investment well within the 3 year limit set; these savings provide substantial financial and environmental benefits to Tesco; and all savings have been made without detrimental effect to plant operating criteria.

Similarly, Telstra, the Australian telephone company commissioned a test on their central office locations. The results were that: the evaluation clearly demonstrated an overall reduction in electricity consumption of 30% when the Energy Saving Module System 4000™ was operating; this reduction resulted in a straight-line return on investment of 33% or 36 months; and the total number of compressor starts increased by only 3 per day when the ESM™ was on, however the compressor running time was reduced by 36%. The benefits of the reduced compressor running would exceed any adverse effect of the increased starts. Telstra stated that this evaluation has comprehensively shown the ESM System 4000™ to be a cost effective and reliable energy management tool whose performance can be easily measured and verified.

Since 1992, over 25,000 Energy Saving Modules™ have been sold or installed worldwide. In that time, Smartcool products have reduced electricity consumption by 1.2 Million Mwh, eliminating over 1.4 Million Tons of Greenhouse Gas Emissions.

Currently it is estimated that world wide the Energy Saving Modules™ are reducing electricity use each year by 213,000 Mwh and Greenhouse Gas emissions by 255,000 Tons. This is enough electricity to supply a city with a population of 250,000 people.

8. WHAT IS NEEDED?

For the Kyoto accord and other greenhouse gas emission reduction initiatives to work, it is important for a number of areas to focus on both clean power alternatives and reducing the reliance and use of existing power sources.

Support from governments around the world is needed to assist in the acceptance and implementation of technologies like the ESM 4000™. This could come in the form of grants, funding, and low interest loans to Companies who adopt these technologies. Additionally, legislation that enforces business and residential to reduce their power usage will ensure we can meet the aggressive targets we are committed to.

Secondly, the Utilities that provide these power services must also embrace technologies such as these. Many of the U.S. Utilities provide rebates to Customers who install these technologies. This improves the return on investment for the Customer, but also reduces the cost of infrastructure that the utility would otherwise be required to build. This may also be another source for low interest loans to Companies who install these.

Additionally, industry must embrace these technologies. With a strong return on investment of between 24 and 36 months, there exists a strong financial business case for these products. More importantly, the strong environmental case needs to be accepted as the responsibility of all Companies and citizens of the world.

Ultimately, it will take all of us to meet the need for reduction of fossil-fuel energy dependence.

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