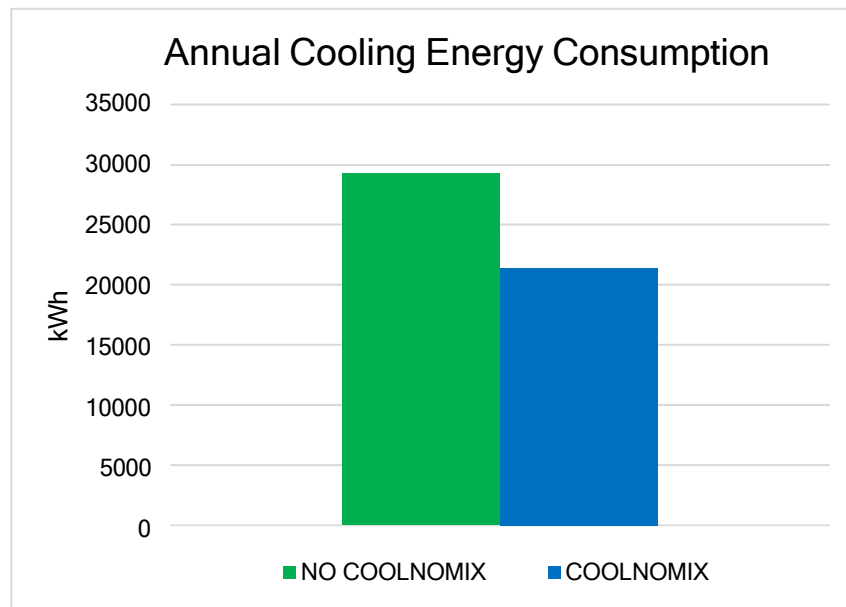


## White Paper

*This white paper, intended for building owners as well as energy and facility managers, describes how COOLNOMIX® reduces energy waste and improves indoor comfort.*

**COOLNOMIX®** is an energy-efficient technology for decreasing the costs of air conditioning, refrigeration and heat pump systems (HVAC/R). With no risk to existing equipment, this simple add-on device uses dual sensors and U.S. patented artificial intelligence software to improve indoor comfort, eliminate short-cycling, and reduce compressor run-times in direct expansion (DX) cooling systems.



Prepared by **PROTEK** Corporation  
75 North Main Street, Randolph, Massachusetts 02368  
(781) 963-8813  
[info@protekcorporation.com](mailto:info@protekcorporation.com)

## EXECUTIVE SUMMARY

This white paper discusses the COOLNOMIX® energy efficiency device, which improves the overall efficiency of direct expansion (DX) cooling systems.

Compressors in DX systems are notoriously inefficient, even in the newest and most advanced HVAC/R equipment. Compressors consume up to 90% of the energy used for cooling and refrigeration. Additionally, oversized HVAC

systems, poorly placed thermostats, and large temperature swings all lead to excess cooling energy consumption and an unsatisfactory indoor climate.

COOLNOMIX® addresses these issues by reducing excessive compressor run times and minimizing temperature swing. This leads to reduced energy use, increased financial savings, and enhanced indoor comfort.



COOLNOMIX® is a simple add-on energy efficiency device that can:

1. Decrease **COOLING ENERGY** consumption by **30%**
2. Achieve a **PAYBACK PERIOD** of under **2 YEARS**
3. Enhance **INDOOR COMFORT** and **PRODUCTIVITY**
4. Reduce energy-related **EMISSIONS**

Simply install **COOLNOMIX®** on your air conditioning or refrigeration system and realize immediate energy and financial savings!

## COOLNOMIX® HIGHLIGHTS

<b>TECHNOLOGY</b>	<b>A simple, energy efficiency add-on technology</b> that uses data from two temperature sensors to help the existing control system improve <b>indoor comfort</b> and reduce <b>excessive compressor runtimes</b>
<b>PAYBACK</b>	<b>Low cost</b> , rapid simple payback of <b>1-2 years</b> (without incentives)
<b>COMPATABILITY</b>	Compatible with <b>direct expansion</b> systems in <b>commercial</b> and <b>industrial</b> buildings
<b>ENERGY</b>	Reduces cooling energy consumption by <b>20-40%</b>
<b>TEMPERATURE</b>	Reduces <b>temperature swing</b> which increases <b>indoor comfort</b> and <b>productivity</b>
<b>WARRANTY</b>	Three-year manufacturer's warranty
<b>CERTIFICATIONS</b>	CE, C-Tick, ETL, FCC, RoHS Certifications
<b>OTHER</b>	UL-listed and US Patented

## PROBLEM STATEMENT

Though heating, ventilation, air conditioning and refrigeration (HVAC/R) systems may be thought of as modern conveniences, many common HVAC technologies are dated. Typical direct expansion (DX) cooling systems, which expand and compress a refrigerant to remove heat from a space, can be highly inefficient and waste a significant amount of energy. Common issues in DX systems are described in the table below.

ISSUES IN DIRECT EXPANSION SYSTEMS	
<b>Compressors are notoriously inefficient</b>	<b>Compressors</b> in DX units consume up to 90% of the energy used for cooling. Even in the newest and most advanced systems, compressors run excessively and are notoriously inefficient.
<b>HVAC systems are typically oversized</b>	HVAC systems are typically sized according to their peak cooling load and may perform less efficiently during normal partial load conditions. During these conditions, the <b>compressor</b> may experience repeated short-cycling which can decrease its lifetime and waste energy.
<b>Thermostats can be inaccurate</b>	Thermostats can be sensitive to temperature fluctuations due to doors opening, solar heat, and occupancy changes. Poorly placed thermostats may not accurately represent the overall temperature of the space and cause the <b>compressor</b> to run excessively, leading to overcooling.
<b>Negative effects on indoor comfort and productivity</b>	Temperatures typically swing 4 degrees F around the thermostat's setpoint, which decreases thermal comfort. This factor, along with overworked <b>compressors</b> and poorly placed thermostats, can decrease productivity and result in large financial losses.

As you can see, a majority of these issues revolve around **inefficient compressor use**. What can be done to address compressor waste in DX systems?

## ALTERNATIVE SOLUTIONS

Typical HVAC retrofit and add-on options can be very **expensive** and require complex and costly installations. Moreover, **NONE** of these directly **address** the biggest energy hog, **excessive compressor runtimes**.

Alternative Solutions	Purpose	Disadvantage
Smart Thermostat	Remote control of temperature settings and scheduling to increase indoor comfort	None of these address excessive compressor runtimes
Fan Speed Controls	Control fan speed of system to reduce energy use	
VRF/VFD	Reduces power to compressor motor during part-load conditions	
Electronic Expansion Valves	Controls the flow of refrigerant entering a direct expansion evaporator	
Economizers	Uses outside air to cool the space to reduce AC use	
HVAC Replacement	Upgrade to a more efficient system	

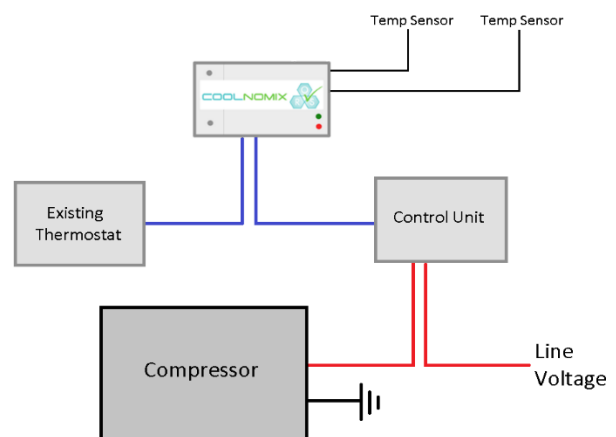
## SOLUTION:

### COOLNOMIX® ENERGY EFFICIENCY TECHNOLOGY

COOLNOMIX® is an energy efficiency retrofit add-on control device that increases cooling and refrigeration system efficiency by 30% on average. COOLNOMIX® works by specifically targeting the compressor to ensure it properly cools the space without running excessively. **It's like a pacemaker for your cooling system!**

The COOLNOMIX® device is slightly larger than a smartphone and is typically installed between the thermostat and the compressor control unit. It utilizes two temperature sensors and patented AI software to help the existing cooling system optimize compressor runtimes. This reduces energy waste while improving indoor comfort and productivity.

COOLNOMIX® only functions when the existing thermostat system is calling for cooling. As it can only prevent excessive compressor use, not increase it, the cooling system will never use more energy than typical with COOLNOMIX®. The greater the cooling demand, the greater opportunity for savings from COOLNOMIX®!



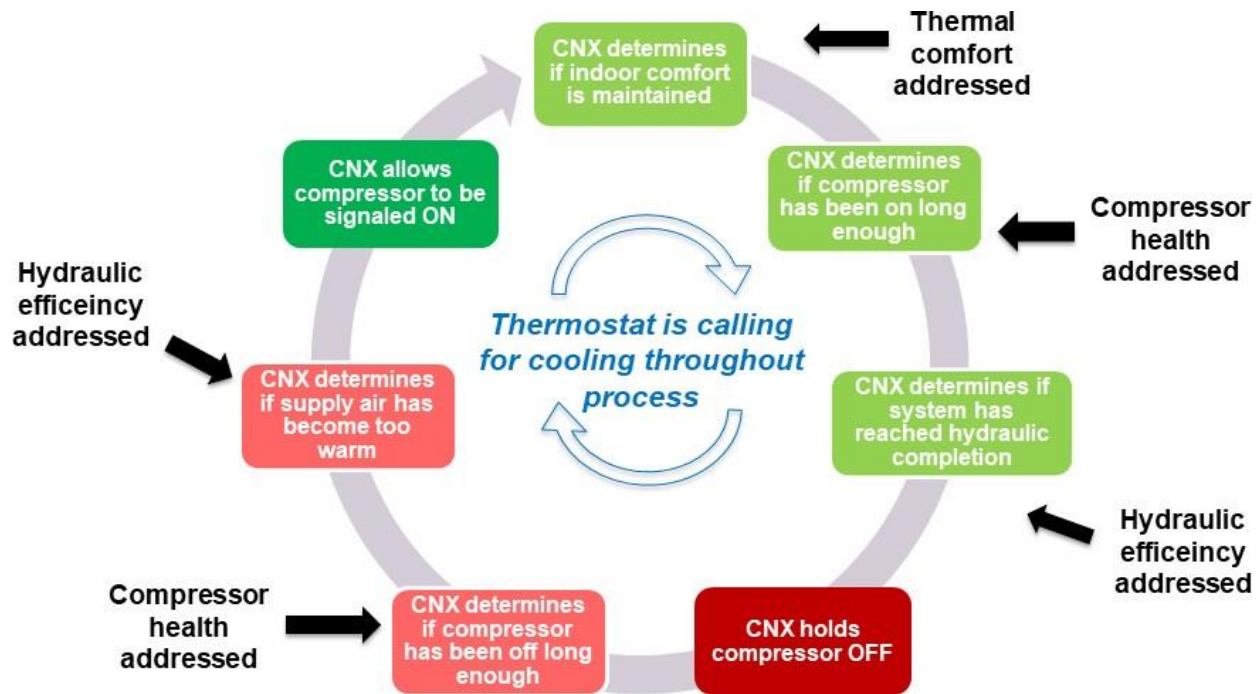
COOLNOMIX INSTALLATION

The basic steps in the COOLNOMIX® process include the following:

1. COOLNOMIX® utilizes **two temperature sensors**, typically placed in the supply and return air vents, to more **accurately measure** indoor and supply air temperature.
2. The COOLNOMIX® software utilizes the temperature sensor readings to determine if **optimal indoor comfort** has been achieved and if the compressor is about to run **excessively**.
3. Once the software has determined that the above requirements have been met, COOLNOMIX® opens the relay from the thermostat to the compressor control, **stopping the compressor** from running excessively.
4. When the indoor and supply air temperature have increased above the desired level, COOLNOMIX® will close the relay and **allow the compressor to run** again.

This cycle ensures the space maintains a comfortable temperature while reducing excessive compressor runtimes—saving energy, money, and satisfying occupants.

## THE COOLNOMIX CYCLE



During this cycle, COOLNOMIX® typically reduces temperature swing by half. For refrigeration, this reduces spoilage and product safety risks. For air conditioning, this improves occupant comfort and thus productivity. Moreover, it can eliminate the #1 and #2 office complaints: **“It’s too cold/hot!”**

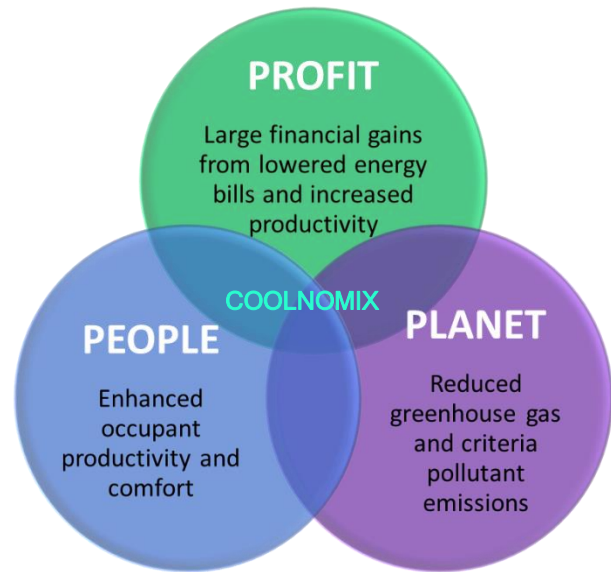
Additionally, to eliminate compressor short-cycling and improve system health, COOLNOMIX® ensures minimum compressor on- and off-times of three minutes. By running the cooling system more efficiently, COOLNOMIX® can extend the life of

the system and reduce the need for costly replacements.

Finally, the improvement in energy efficiency from utilizing COOLNOMIX® reduces upstream greenhouse gas (GHG) emissions and criteria pollutants, enhancing system sustainability.

**COOLNOMIX® helps the existing cooling system signal the compressor at the optimal time—eliminating excessive runtimes, and thus reducing energy consumption. Related benefits include reduced costs, increased comfort and productivity, and a minimized carbon footprint.**

**THE COOLNOMIX® TRIPLE BOTTOM LINE**



**APPLICABILITY AND IDEAL DEPLOYMENT**

**COOLNOMIX® Applicable Systems**

- Packaged Rooftop Units
- Split Systems
- Ducted and Ductless systems
- VRF/VRV installations
- Commercial Refrigeration Units
- Walk-in Refrigeration Units

COOLNOMIX® is suitable for any air conditioning or refrigeration systems that utilize **direct expansion (DX)**. COOLNOMIX® is NOT suitable for chilled water units or freezers.

COOLNOMIX® only functions when the existing thermostat system is calling for cooling. The greater the cooling demand, the greater the opportunity for COOLNOMIX® to optimize savings and achieve large financial returns. Therefore, ideal deployment situations include operations that use cooling or refrigeration continuously, such as hospitals, data centers, food storage, and any operation in warm climates.

**COOLNOMIX® CONNECT**

COOLNOMIX® CONNECT is an Android application that connects to your COOLNOMIX® device via Bluetooth. The app provides and stores real-time data on energy savings, compressor

runtimes, and air temperatures to simplify the installation verification process and support commissioning and energy optimization management activities.



The app generates a data log of the COOLNOMIX® state and temperature readings and allows COOLNOMIX® settings to be remotely changed. The mobile device receives alerts through the app when COOLNOMIX® detects compressor failure, a cooling system that requires maintenance, or one that is under-sized when running at peak loads.

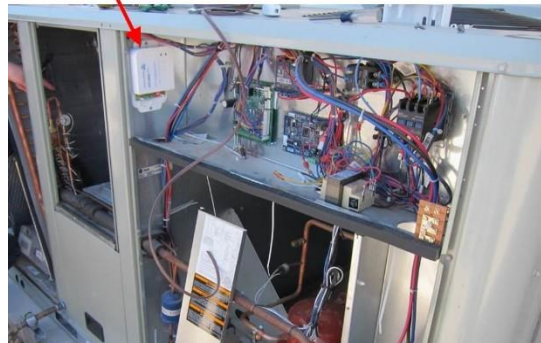


## COOLNOMIX® INSTALLATION AND OPERATION

An HVAC/R technician can install a COOLNOMIX® unit in under one hour. This one-time, non-invasive installation respects the existing cooling system warranty.

Typically, COOLNOMIX® is installed at every location that has a thermostat or temperature controller. It does not require internet connectivity and does not exchange data with BMS or BAS systems at this point. However, COOLNOMIX® CONNECT allows the device to be connected to the COOLNOMIX® Android app via Bluetooth to aid in the M&V process.

COOLNOMIX®



The COOLNOMIX® temperature setpoints are determined at installation and settings do not need to be changed if the setpoints are increased (i.e. during setbacks). If setpoints are decreased, COOLNOMIX® setpoints may be modified to maximize savings opportunities.

No maintenance is needed after installation. **Just install it and leave it!**



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## COST AND SIMPLE PAYBACK

Around the world, COOLNOMIX® typically reduces cooling energy consumption by 20-40%. COOLNOMIX® installation cost ranges from \$900-\$1,500 (this includes installation materials, labor, and the cost of the COOLNOMIX® device).

Once properly implemented, the simple payback is typically **1-2 years**; however, certain factors are associated with a faster or slower payback, which include HVAC system type, exterior conditions, interior loads, electricity rates, and labor costs.

## BEST PRACTICES

To achieve maximum savings potential from COOLNOMIX®, best-practices must be followed.

<p><b>HVAC Maintenance</b></p>	<p>The HVAC system must be properly maintained in order to optimize savings from COOLNOMIX®. COOLNOMIX® should be integrated into the cooling system's pre-existing preventative maintenance procedures.</p>
<p><b>Occupant Training and Education</b></p>	<p>Frequently changing the setpoints can disrupt COOLNOMIX® savings. When the system is set to "Always-On", cooling is no longer driven by the thermostat. COOLNOMIX® cannot work as intended in these cases. Additionally, steps should be taken to ensure the COOLNOMIX® device will not be disconnected from the cooling system.</p> <p>Occupants should be educated on the location and function of COOLNOMIX®. Signs can be placed next to thermostat and COOLNOMIX® device to prevent setpoint adjustment and disconnection.</p>

## U.S. CASE STUDIES

COOLNOMIX® has been installed in over **46 countries** and continues to save customers **millions of dollars** on their cooling costs. COOLNOMIX® has been independently tested at various locations around the globe including restaurants, universities, banks, offices, and more. Examples of case studies include the following:



HSBC hired JLL to help cut energy costs in bank branches across Asia-Pacific. HSBC saved over HK\$3 million per year by installing COOLNOMIX® in HSBC branches that have DX, ducted, split-type, and VRV/VRF air conditioning systems. After installing 895 units in 55 retail bank offices across five Asia-Pacific countries, JLL documented an average of **27% savings** and a **simple payback period of 7.2 months**.



Nippon Comsys Corp, Japan's largest telecom engineering contractor, piloted 15 COOLNOMIX® units on some of the newest VRF cooling systems. Due to the overwhelming success of the pilot, which averaged **40% savings**, Comsys equipped all Mitsubishi units in their headquarters with COOLNOMIX®. As the design authority of NTT, Comsys has recommended that NTT Docomo roll out 40,000 units at 20,000 mobile phone base stations, estimating NTT would **save \$500 million over 10 years**.



COOLNOMIX® was installed on the RTU at Chelsea Library in Massachusetts, which has significantly more heating degree days than cooling degree days. Even with the low amount of cooling demand, COOLNOMIX® **reduced cooling energy consumption by 23%** which resulted in a **simple payback of 1.5 years**, saving the library around \$700 a year. COOLNOMIX® can produce results, even in cold climates!



COOLNOMIX® was installed on a walk-in refrigerator at an Outback Steakhouse in Australia. Not only did it **reduce energy consumption by 37%**, but it maintained a much tighter temperature control. This resulted in a savings of 11,000 kWh and \$2,200 a year. For restaurants and food service locations with year-round refrigeration needs,



COOLNOMIX® can deliver constant, predictable savings while reducing product safety risks.

## Case studies with 20-50% cooling savings



## CONCLUSIONS

COOLNOMIX® is the ideal solution to improving the efficiency of DX cooling systems. Its dual temperature sensors and patented AI software increase the accuracy of temperature readings and allows for smart cycling of the compressor. Optimizing compressor run times while maintaining ideal internal conditions maximizes occupant comfort at the lowest possible energy cost. The COOLNOMIX® CONNECT mobile application provides accessible measurement and verification of COOLNOMIX® performance. As COOLNOMIX® carves out a new market space by directly addressing excessive compressor runtimes, direct competition is limited. **The low cost, ease of install, and rapid payback make COOLNOMIX® the low-hanging fruit of any energy efficiency and sustainability effort.**



**PROTEK** Corporation

75 North Main Street, Randolph, Massachusetts 02368

(781) 963-8813

[info@protekcorporation.com](mailto:info@protekcorporation.com)

PROTEK Corporation is a distributor of COOLNOMIX®. CoolGreenPower is the master distributor for COOLNOMIX® in the U.S. and Canada.

COOLNOMIX® Technical Specifications	
<b>Unit Types*</b>	<p><b>AC-01 500:</b> For cooling systems sized ≤ 5 tons</p> <p><b>AC-01 501:</b> For cooling systems sized &gt;5 tons</p> <p><b>AC-01 CRAC:</b> For computer room systems sized &gt;5 tons</p> <p><b>AR-01 700:</b> For refrigeration systems up to 630 SF</p> <p><b>AR-01 701:</b> For refrigeration systems over 630 SF</p> <p>*COOLNOMIX® CONNECT is compatible with all models.</p>
<b>Dimensions</b>	7" x 4.4" x 1.5" in.
<b>Unit Weight</b>	12 oz
<b>Supply Voltage</b>	110V - 250VAC 50/60Hz auto-switching
<b>Current</b>	2mA (220V), 1mA (110V)
<b>Operating Environment</b>	30°F to 131°F, RH to 95%
<b>Storage Environment</b>	-13°F to 185°F, RH 15% to 95%
<b>Certifications</b>	ETL (UL 60730-2-9, UL 60730-1), CE, CTICK, FCC, RoHS
<b>Temperature Settings</b>	NTC type, -58°F to 302°F
<b>Control Relay</b>	<p>Normally Closed (NC) - closes on power failure</p> <p>Voltage: 0 to 250V (AC or DC)</p> <p>Current: 10A continuous/16A peak</p>
<b>Warranty and Lifetime</b>	<p>Manufacturer's warranty: 3 years*</p> <p>Expected lifetime: 10+ years</p> <p>*Tens of thousands of units have been in operation for 3 years or longer, with NO failures to date</p>