



Hilman Widianoro
Honeywell

LOW GLOBAL WARMING POTENTIAL REFRIGERANT

Honeywell
THE POWER OF **CONNECTED**

Honeywell Overview



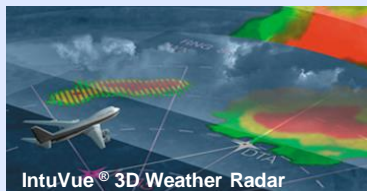
\$40.5B

in sales for 2018

- More than 110,000 employees
- ~970 sites
- Morris Plains, N.J. headquarters
- Fortune 100
- NYSE: HON

Aerospace

\$14.8B
Sales



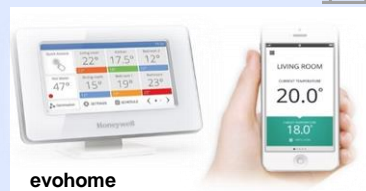
IntuVue® 3D Weather Radar

Unmatched Scope of Offerings

- Mechanical, Cockpit, and Software Offerings From Nose to Tail
- Apps, Services, Maintenance, Subscriptions
- End-to-End Connectivity Solutions From Hardware to Airtime
- Turbochargers for Fuel Efficiency

Home and Building Technologies

\$9.8B
Sales



evohome

Connecting Homes and Buildings

- Security and Fire
- Connecting Homes With Lyric™
- Open Software Connecting "Internet Of Things" in Buildings

Performance Materials and Technologies

\$10.3B
Sales



Experion® Orion Console

Winning Technology

- Refining and Petrochemical Catalysts
- Gas Processing Modular Offerings
- Solstice® LGWP Materials
- SmartLine Transmitters
- Asset Optimization Software

Safety and Productivity Solutions

\$5.6B
Sales

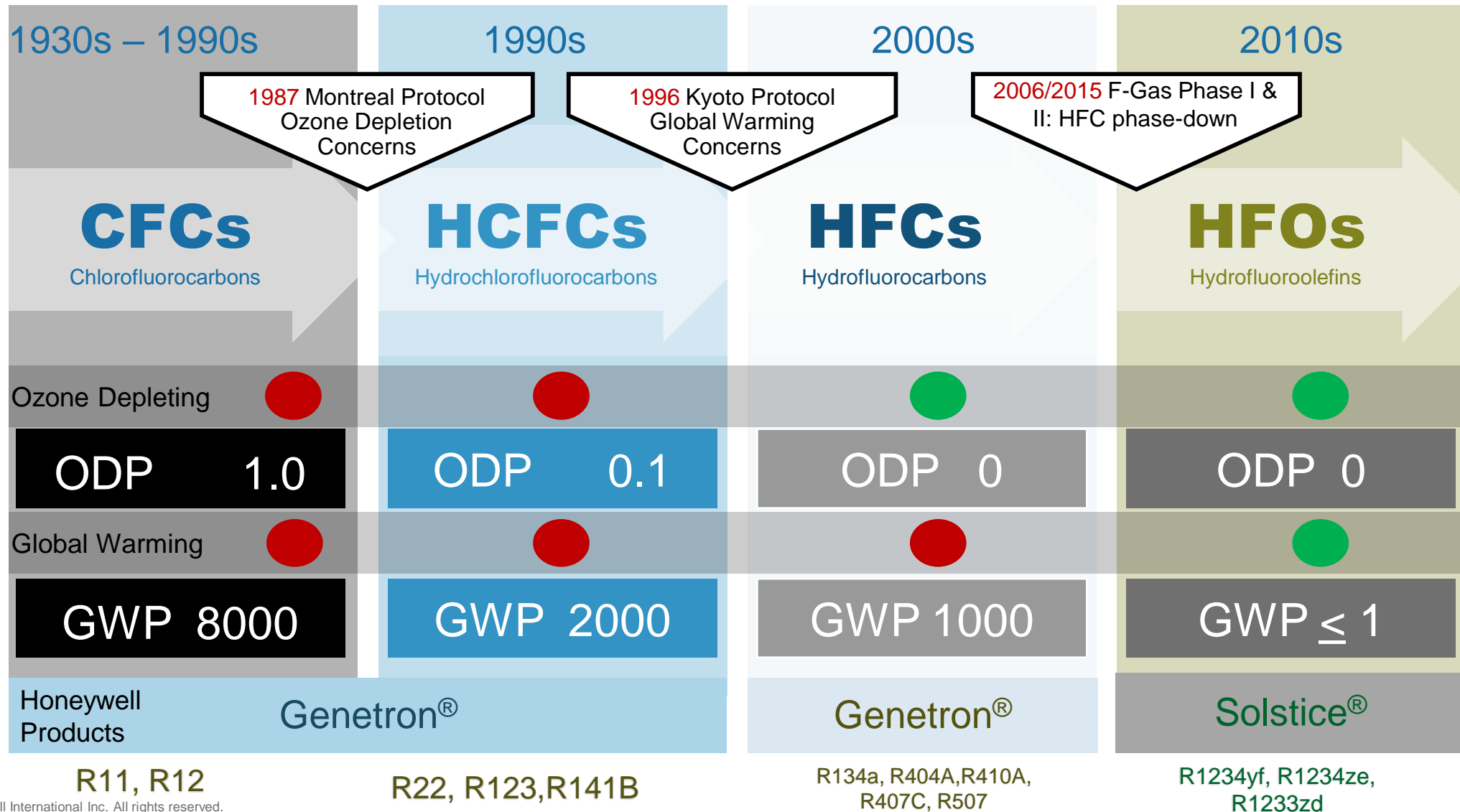


Vocollect™

Connecting Workers

- Wireless, Voice, Mobility, Data Analytic Solutions for Workers
- Warehouse Automation
- Keeping Workers Safe

Innovation History of Refrigerant



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Honeywell enabling environmental breakthroughs

Kigali Amendment Oct16:HFC Phase down

	Non-A5 (developed countries)	A5 (developing countries) Group 1	A5 (developing countries) Group 2
Baseline HFC component	2011-2013 (average consumption)	2020-2022 (average consumption)	2024-2026 (average consumption)
Baseline HCFC component	15% of baseline	65% of baseline	65% of baseline
Freeze	-	2024	2028
1st step	2019 - 10%	2029 - 10%	2032 - 10%
2nd step	2024 - 40%	2035 - 30%	2037 - 20%
3rd step	2029 - 70%	2040 - 50%	2042 - 30%
4th step	2034 - 80%	-	-
Plateau	2036 - 85%	2045 - 80%	2047 - 85%
Notes	Belarus, Russian Federation, Kazakhstan, Tajikistan, Uzbekistan, 25% HCFC component and 1st two steps are later: 5% in 2020, 35% in 2025	Article 5 countries not part of Group 2	GCC (Saudi Arabia, Kuwait, United Arab Emirates, Qatar, Bahrain, Oman), India, Iran, Iraq, Pakistan

Resource from <https://eia-international.org/wp-content/uploads/EIA-Kigali-Amendment-to-the-Montreal-Protocol-FINAL.pdf>

Honeywell Fluorine Products Overview

Business Segments



Auto

- Solstice® yf



Stationary

- Solstice® N40
- Solstice® N13
- Solstice® zd
- Solstice® ze
- Genetron Performax® LT
- Genetron® 422D
- Genetron® AZ-20®
- Genetron® AZ-50®
- Genetron® 404A



Foam

- Solstice® LBA
- Solstice® GBA
- Enovate® 245fa



Nuclear
Fuel

- Solstice® Propellant
- Solstice® Performance Fluid
- Solstice® PF-C



Industrial /
A&S

Global R&D Locations

Fluorine Products Locations **5**
Fluorine Products Employees **1,100**

- Buffalo, NY
- Shanghai, China
- Gurgaon, India

New Products



Honeywell Smart Refrigeration Solution

New Products

- Solstice® HFOs: 1234yf, 1234ze, 1233zd and blends
- Non-flammable 410 replacement : Solstice® N41
- Digital software solution

Technology Leadership

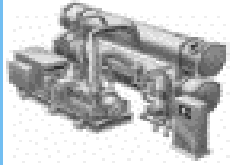










Honeywell Performance Materials

14,794 total active portfolio (pending & granted)

Fluorine Products

4,127 active portfolio (pending & granted) of which 949 EU

Next Generation Solstice HFO & HFO Blends

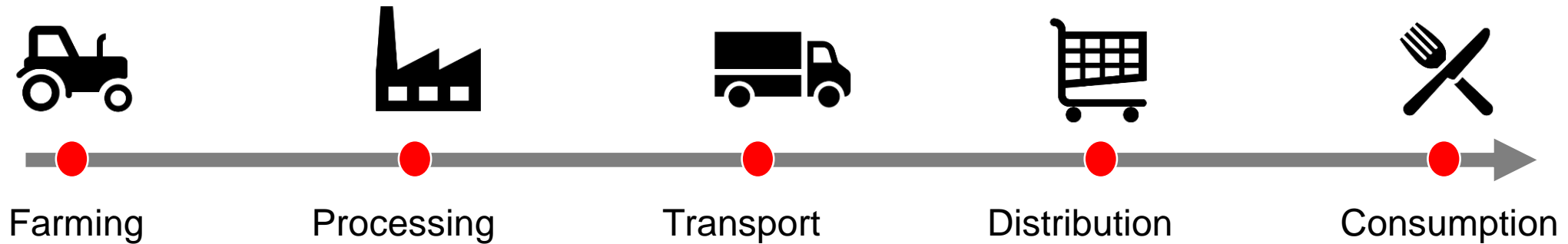
Current Product	Non Flammable (A1)		Mildly Flammable (A2L)	
R-123 GWP= 79	Solstice zd R-1233zd GWP=1	 <i>Centrifugal Chillers</i>		
R-134a GWP=1300	Solstice N13 R-450A GWP=547 R-515B GWP <300	 <i>M Temp Commercial Refrigeration</i>	Solstice yf R-1234yf GWP<1	Solstice ze R-1234ze GWP<1  <i>M Temp Refrig Mobile A/C Chillers Heat Pumps</i>
R-22 GWP=1760	Solstice N40 R-448A GWP=1273	 <i>M & L Temp Commercial Refrigeration</i>	R-444B GWP=295  	<i>Stationary / Comfort A/C</i>
R-404A GWP=3943 + Interim Blends	Solstice N40 R-448A GWP=1273	 <i>M & L Temp Commercial Refrigeration</i>	Solstice L40X R-455A GWP=146 	<i>M & L Temp S/C Refrigeration Waterloop Heat Pumps</i>
R-410A GWP=1924	Solstice N41 R-466A* GWP 733	 <i>Stationary / Comfort A/C/ VRF</i>	Solstice L41y R-452B GWP=676  	<i>Stationary / Comfort A/C</i>

Note: All GWP values from the IPCC, "AR5" *Provisional ASHRAE number

Solstice® HFO blends | New Solutions for Refrigeration

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Cold Chain Impact



- Cold chain is the **transportation of temperature-sensitive products along a supply chain** through thermal and refrigerated packaging methods and the logistical planning to protect the integrity of these shipments **across the food chain “from farm to fork”**
- The common range of temperatures for a cold chain in the food industry are **chilled** (0°C to 5°C) and **frozen** (-18°C to -24°C). However, specific temperature tolerances depend on the product being stored and transported

R-450A
(601 GWP)

- Med temp in Supermarkets
- Commercial Cabinets
- Med temp warehousing

R-448A
(1273 GWP)

- Convenience Stores
- Supermarkets
- Cold Stores / Distribution w/h

R-452A
(2156 GWP)

- Refrigerated Road Transport
- Commercial Cabinets
- Refrigerated Sea Transport

R-455A
(146 GWP)

- Convenience Stores
- Kitchens / Restaurants
- Commercial Cabinets
- Fresh Food Storage

Refrigerated Road Transport

Solstice 452A
(R-452A)



REFRIGERANT CONVERSION GUIDE

45%

immediate reduction in
environmental impact

THERMO KING'S F-GAS STRATEGY

FUTURE PROOFING YOUR BUSINESS

Thermo King has invested heavily in the development of innovative technologies that minimise environmental impact while giving uncompromised performance and reducing operating costs.

Leveraging their 75-plus years of experience and the expertise of the Ingersoll Rand group, Thermo King has researched the most suitable alternative to R-404A, the refrigerant most commonly used in road transport today.

THE RESULT IS R-452A, A HYDROFLUORO OLEFIN (HFO) BASED BLEND OFFERING AN IMMEDIATE REDUCTION IN ENVIRONMENTAL IMPACT OF 45%.



Global Trends in Retail Refrigeration

• Convenience Stores

- Strong growth
- Smaller charge unitary equipment
- Growth of self-contained integral systems



• Small Supermarkets

- Steady growth
- Development of new architectures
- More efficient cooling & HVAC energy management (waterloop, semi-distributed)



• Supermarkets

- Flat growth
- Semi-distributed architectures and cascade systems promise better eco-efficiency



• Hypermarkets

- Declining
- Centralized systems common
- Cascade systems promise better eco-efficiency



Solstice[®] N40 (R-448A)

- Nonflammable (ASHRAE A1) and non-ozone depleting
- GWP of 1273 is 68% lower than R-404A (AR5)
- Proven energy efficiency: 5 - 16% lower consumption vs R-404A
- U.S. EPA SNAP listed & UL listed
- Meets EU F-Gas and Japan Emission Control Act
- Qualified for use by all major component manufacturers

**20000+
Installations
Globally**

Refrigerant Properties

Refrigerant	R-404A	N40 (R-448A)
Mixture	R125/R143a/R134a	R125/R32/R134a/R1234yf/R1234ze
Composition, %	44/52/4	26/26/21/20/7
Type	HFCs	HFCs & HFOs
Ozone Depletion Potential (ODP)	ZERO	ZERO
Global Warming Potential (AR5 report, GWP)	3943	1273 (32% of R404A GWP)
ASHRAE Safety Class	A1	A1
Flammability	Non flammable	Non flammable
Toxicity (allowable limit, ppm)	1000	1000

Comparison of Performance

Refrigerant	R-404A	N40 (R-448A)
Boiling Point, C	-46.2	-45.9
Critical Temperature, C	72.1	83.7
Lubricant type	Polyol Ester	Polyol Ester (no change)
Mean Pressure @ -30C, Bar-g	1.02	0.78
Mean Pressure @ +40C, Bar-g	17.1	16.6
Cooling Capacity	100 (Base)	98-105
Coefficient of Performance (COP)	100 (Base)	105-115

Toshiba Carrier tests Solstice N40 in Japan

TOSHIBA

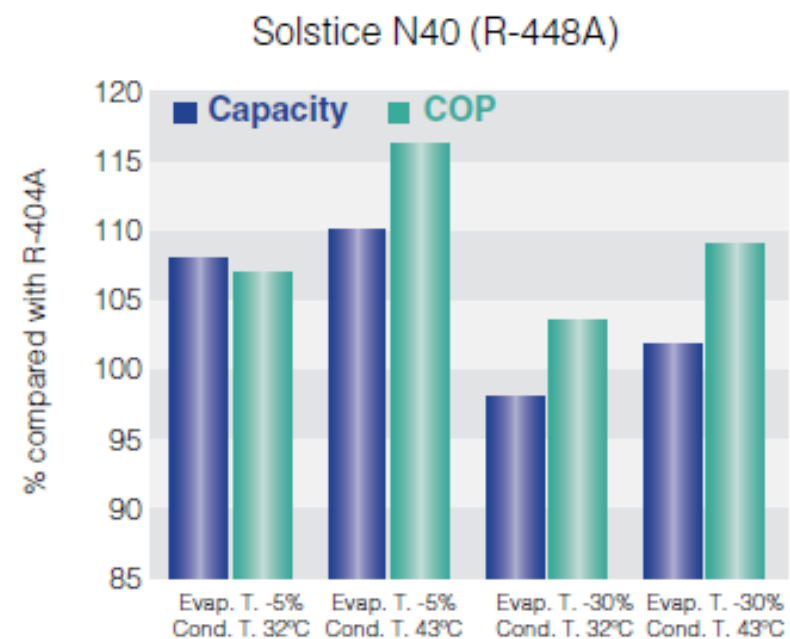
Carrier

(Japan): Solstice N40 in condensing unit

- Condensing unit performance test
- Trials* in accordance with the JIS 8623 standard at 32°C and 43°C
- Solstice® N40 (R-448A) showed a 4%-16% higher COP and excellent equality in capacity

*Performance evaluation of condensing unit using low GWP refrigerants. Atsushi BABA, Hiroichi YAMAGUCHI, Toshiba Carrier Corporation, Fuji-shi, Shizuoka-ken, 416-8521, Japan

“Solstice N40 is a refrigerant that is well-designed to meet the requirements for replacing R-404A.”



Solstice N40 adoption in Thailand

Tesco Lotus, a leading retailer in Thailand and part of Tesco Group, is converting 900 Tesco Lotus Express stores to Honeywell's Solstice® N40 refrigerant to voluntarily reduce carbon emissions. It is the first implementation in Asia of Solstice N40, the most widely accepted, lowest global-warming-potential (GWP), non-flammable replacement for R-404A in the supermarket industry.



Tesco—the global parent company of Tesco Lotus in Thailand—is upgrading its supermarket refrigeration systems worldwide to lower-GWP refrigerants as part of its commitment to reduce its carbon footprint. By converting all of its 1,500 Express stores in Thailand over the next two years to Honeywell's Solstice N40 (R-448A), the retail giant aims to achieve energy savings of up to 10 percent. This is equivalent to removing more than 67,000 cars from the road.



Solstice N40 adoption in Japan

JAPANESE RETAILER SEVEN-ELEVEN ADOPTS HONEYWELL'S ENVIRONMENTALLY PREFERABLE REFRIGERANT

Honeywell's Solstice® N40 refrigerant (R-448A) will help lower costs and reduce carbon footprint at stores across Japan

Seven-Eleven is first leading retail chain in Japan to adopt Solstice N40

TOKYO, October, 1, 2018 – Honeywell (NYSE: HON) today announced that Seven-Eleven will be Japan's first leading retail chain to adopt its next-generation [Solstice® N40 \(R-448A\)](#) refrigerant as a lower global-warming-potential (GWP) alternative to the older R-404A refrigerant, which has an impact on global warming that is more than 3,900 times that of carbon dioxide.

Seven-Eleven is adopting Solstice N40, which offers a 65 percent reduction in global warming potential compared with R-404A, to comply with strict GWP reduction targets set for the Japanese food retail industry. Seven-Eleven has begun installing the environmentally preferable Honeywell refrigerant in condensing units (manufactured by Hitachi-Johnson Controls Air Conditioning and distributed by Hitachi Appliances) at all new and renovating stores across the country.

Industry leaders, Seven-Eleven Japan (operator of Seven-Eleven convenience stores), Hitachi Appliances, Hitachi-Johnson Controls Air Conditioning and Honeywell conducted a series of trials before selecting Solstice N40. A full year of data showed Solstice N40 led to 20 percent energy savings in the Hitachi condensing units compared to R-404A.

"The trial results confirmed that Solstice N40 is an effective solution for our large estate of convenience stores in Japan to achieve our goals in reducing both overall carbon footprint and operating costs," said Mr. Hisashi Ohashi, Head of Construction & Equipment Department, Director & Executive Officer, Seven-Eleven Japan.



From Right, Mr. Mr. Hisashi Ohashi, Head of Construction & Equipment Department, Director & Executive Officer, Seven-Eleven Japan and Anna An, Vice President and general manager of Honeywell's Advanced Materials, Asia Pacific.

Asia Pacific Success Stories

Solstice N40
(R-448A)
1273 GWP

Solstice N40 is also enjoying growing success in other countries in APAC region:

Japan:

- Seven 11 Japan – N40 Adopted along with CDU's
- Other major supermarkets under final trials



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Seven-Eleven is first leading retail chain in Japan to adopt Solstice N40

China:

- Auchan
- Carrefour / Walmart + others running trials on N40 – to prove performance

Philippines:

- Promote use of N40 / N13 & L40X products

Malaysia:

- KLCC cold storage stores

Taiwan:

- Interest with supermarkets and cold room users

ANZ Region:

- Coles supermarket adopted / other applications working well

Other countries also seeing good interest in trailing / adoption of N40

'Kicking Goals' at Perth Stadium

- Prestigious new Perth sports stadium
- R-448A used in MT and LT
- Lower carbon footprint / running costs
- -40°C Blast Freezers
- Custom designed W/Cooled & A/Cooled Condensing units

R-448A adoption growing in APR

Solstice[®] N40 Adoption



3,700+
Stores

17,000+ Stores

2,500+
Stores

Selected Solstice N40 stores



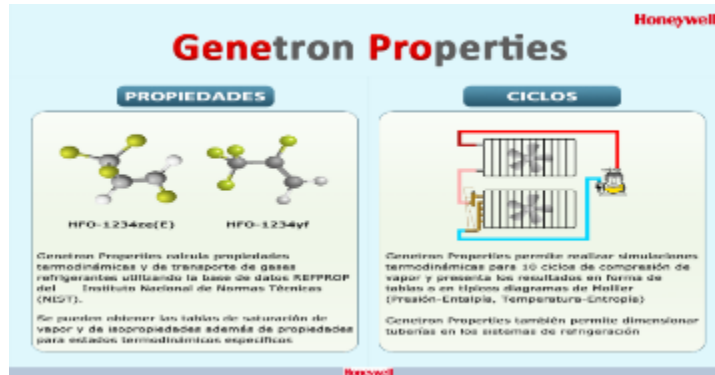
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Most widely adopted lower GWP non-flammable, R404A alternative for supermarkets

Honeywell Apps, Online and Software Tools and Other



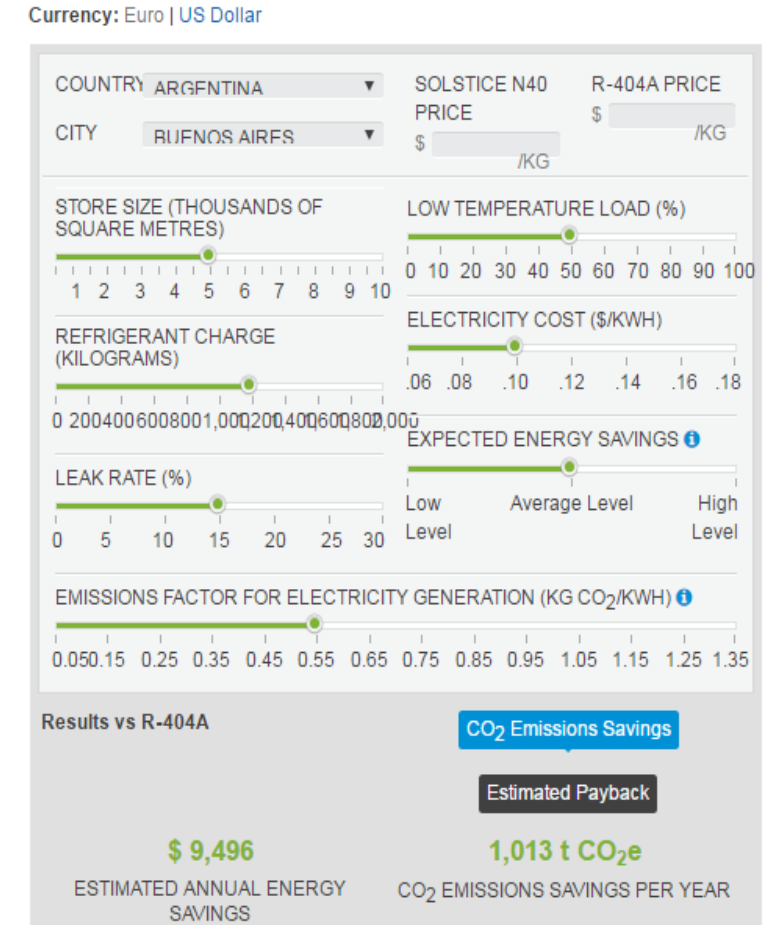
Training video



Genepro simulation software



Retrofit guideline

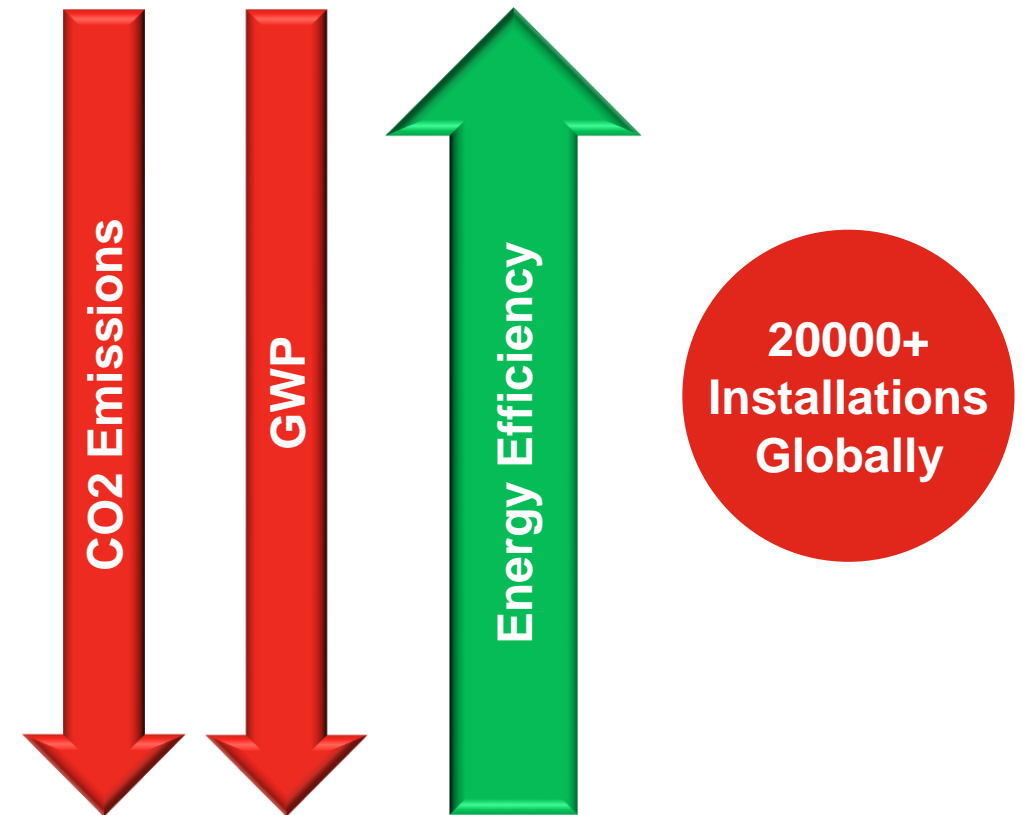


Savings calculator Solstice® N40

In Summary

Solstice N40 (R-448A)

- Help end-users meet HFC phase-down targets (Kigali Amendment)
- Provide design flexibility (similar capacity and pressure)
- Maintain / improve safety in workplace (e.g. ASHRAE A1 Class)
- Improve system energy efficiency
- Allow end-users & industry meet their environmental goals



Honeywell is building a smarter, safer,
and more sustainable world

THAT'S THE POWER OF **CONNECTED**
THAT'S THE POWER OF **HONEYWELL**

Connected Aircraft • Connected Automobile • Connected Home • Connected Building
Connected Plant • Connected Supply Chain • Connected Worker

Honeywell

THE POWER OF **CONNECTED**

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