AGRAMKOW

AGRAMKOW Fluid Systems

MAC and RAC
refrigerant status and outlook
KVCA September 2011




Bjarne Lund

AGRAMKOW

Content

- MAC
  - Flashback
  - Current R1234yf OEM status
  - The current and future needs

- RAC
  - AC trends
  - US status
  - Coca-Cola

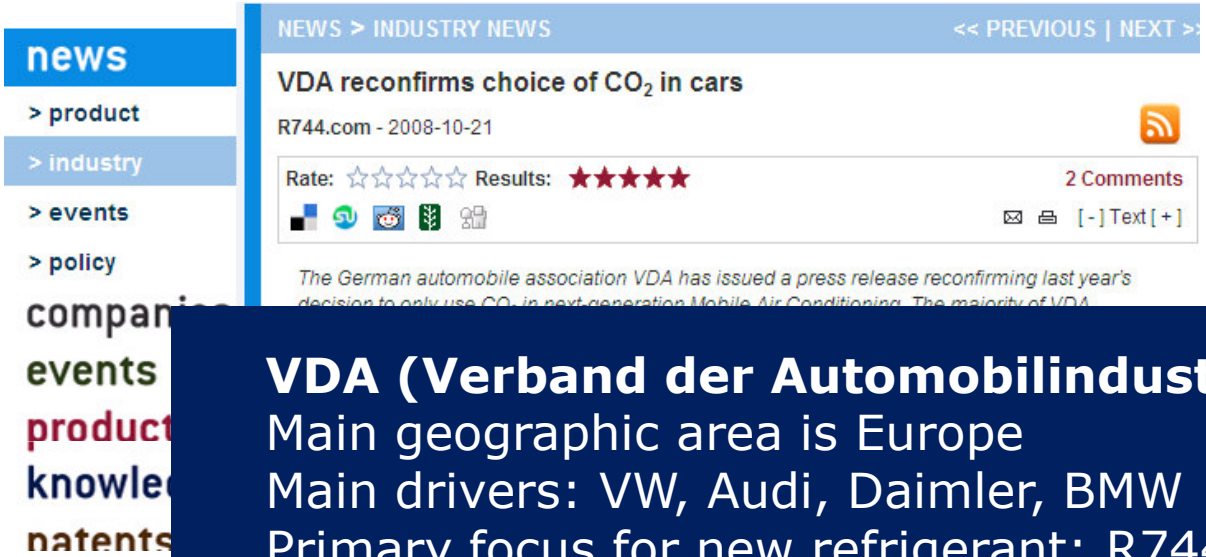
AGRAMKOW

R744 vs R-1234yf

Animation

AGRAMKOW

VDA vs. SAE



VDA (Verband der Automobilindustrie)
Main geographic area is Europe
Main drivers: VW, Audi, Daimler, BMW
Primary focus for new refrigerant: R744

SAE (Society of Automotive Engineers)
Main geographic area is USA
Main drivers: Ford, GM, Chrysler
Primary focus for new refrigrerant: HFO1234yf

AGRAMKOW

Decision off the track


SAE International
HFO-1234yf Cooperative Research Programs
Cooperative Research Programs (CRP) have been sponsored by automobile manufacturers and Tier One/Two Suppliers
Global Vehicle OEMs
Audi, BMW, Chrysler, Daimler, Fiat, Ford/Volvo, General Motors/Opel, Hyundai, Porsche, PSA, Renault, Shanghai Automotive, Tata, Jaguar Land Rover, Toyota, VW
Tier One/Two Suppliers
DuPont, Honeywell, Conti Tech, Dayco, Delphi, Denso, Doowan, Dow, Freudenberg, Goodyear, Hutchinson, Maflow, Egelhof, Parker Hannifin, Sanden, Trelleborg, Valeo, Visteon
11/10/2009
CRP1234
3

Animation

AGRAMKOW

...and the winner is...

R744

3

R1234yf

1

R134a

2

Dark horse
next decade ??

EU F gas directive

Looser by
US tailpipe credit ?

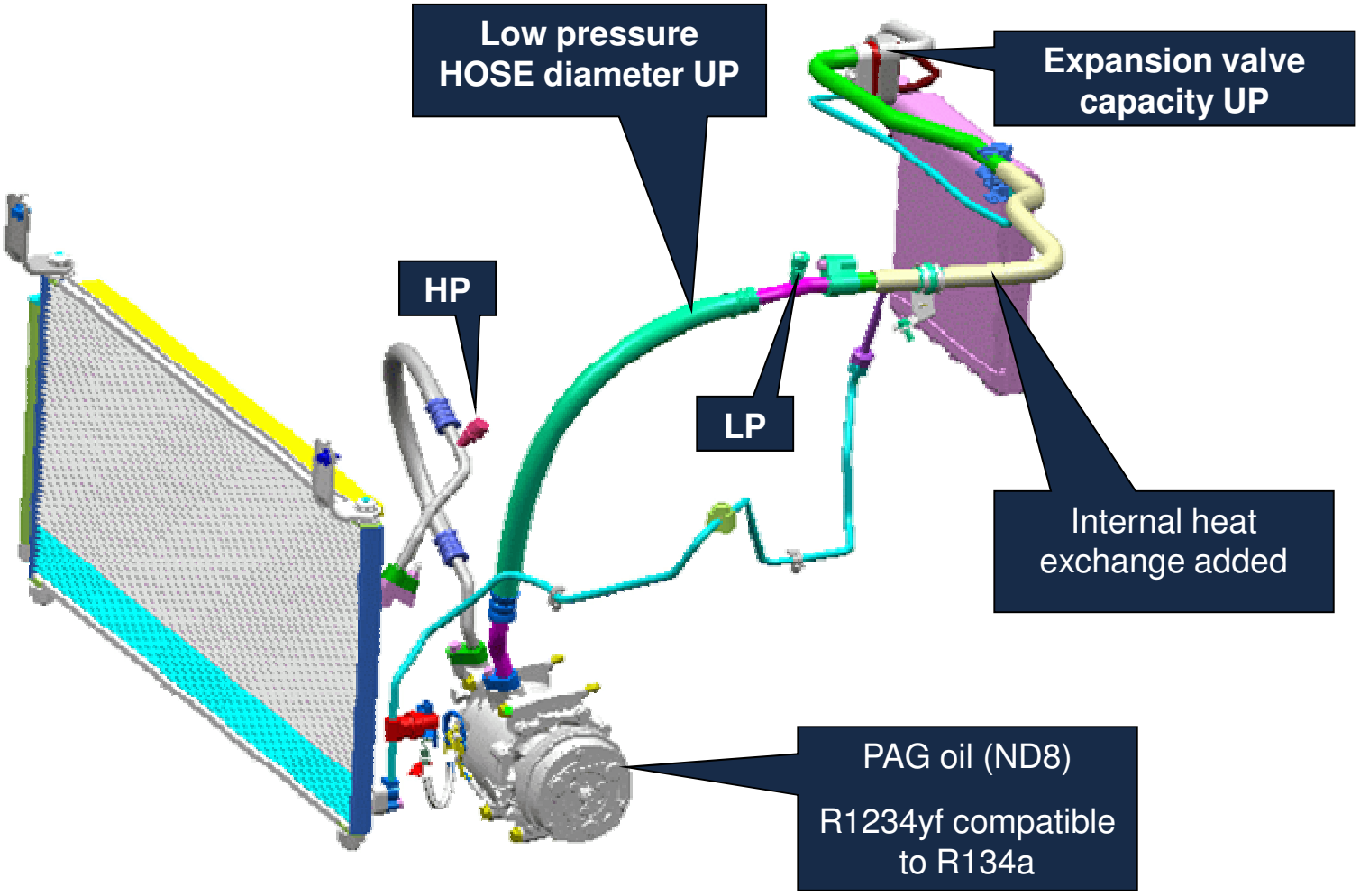
RnD + Fleet test

AGRAMKOW

First delivery 2009W49

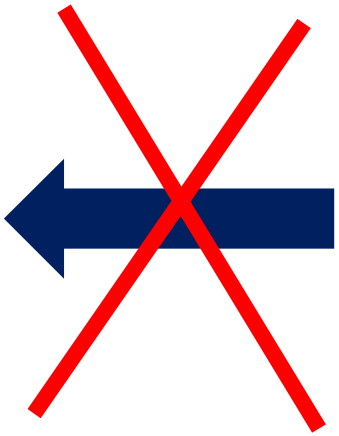
AGRAMKOW

R1234yf MAC versus R134a



Plant integration

Non hazard area

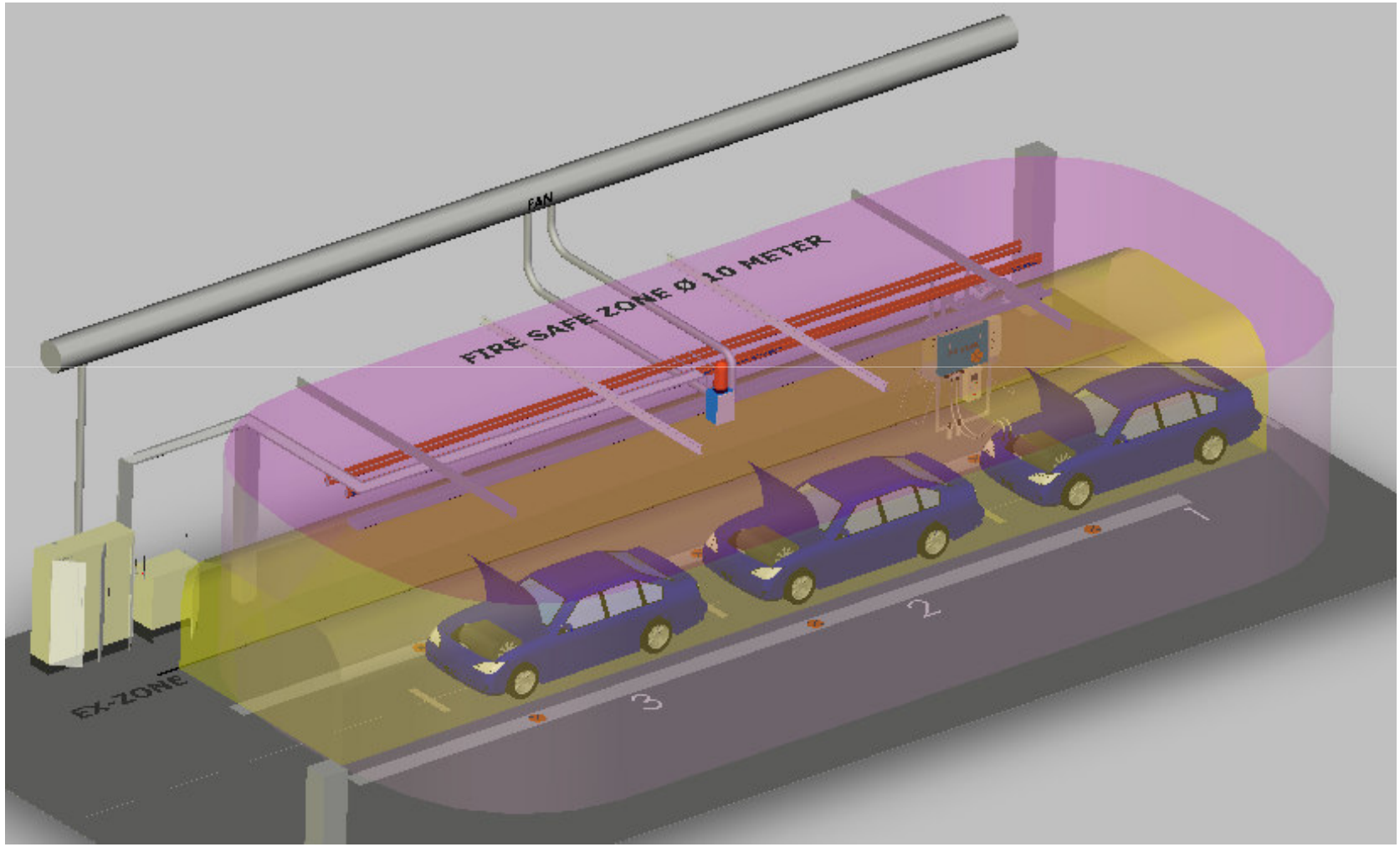


Equipment designed
For Zone 1 or 2

Animation

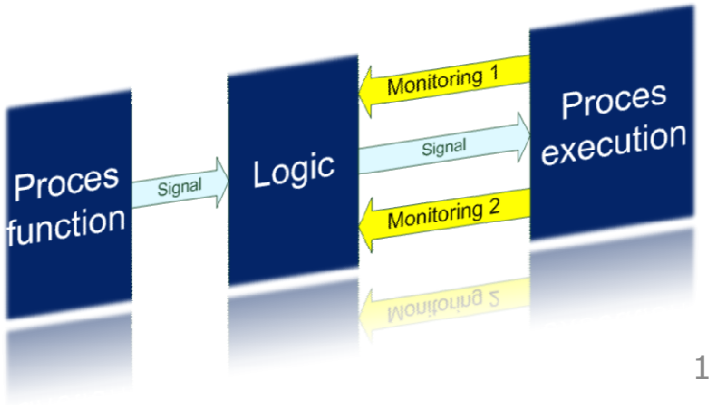
AGRAMKOW

Plant integration



AGRAMKOW

NO ZONE Concept



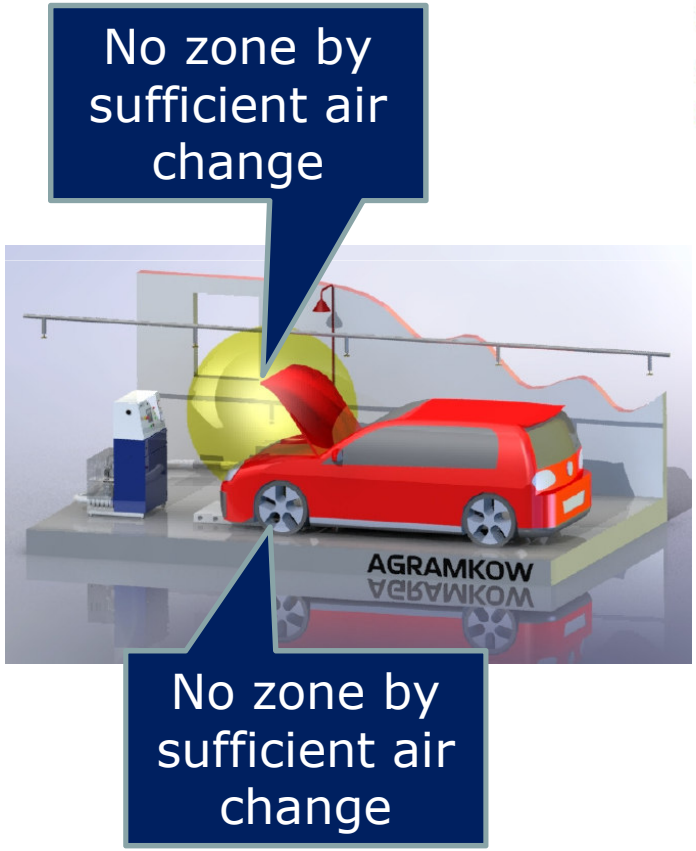
Patent Pending

Health and safety assessment report of R1234yf by TÜV

AGRAMKOW

TÜVRheinland®
Genau. Richtig.

Das Gutachten wurde im Auftrag der VDA-Gruppe des Arbeitskreises Service erstellt und dient als unabhängige Darstellung der sich aus den zahlreichen Untersuchungsergebnissen ermittelten Gefahreneigenschaften. Auf Basis der Gefahreneigenschaften werden die zu erfüllenden technischen und organisatorischen Sicherheitsanforderungen an die Kfz-Werkstätten, deren Umfeld, die Mitarbeiter und das Equipment festgelegt.



Summary: (aftermarket workshops)

Workshop requirements (BGR157 guide lines)
- air change complete workshop n>1/hour
- air change under floor level n>3/hour
- only use of R1234yf certified service equip

Health and safety (BGR157 guide lines)
- use of personal protection devices
- only use of R1234yf certified service equip
- sufficient air change
- service of MACs only by trained personal (acc to F gas directive)

AGRAMKOW

Service marked
We are ready.....

AGRAMKOW

Brand new 2011 vehicle

Still

with high GWP air-con

R134a

Animation

AGRAMKOW

R-1234yf chemical location in China and „volume“ ~~production Q3+Q4 2011~~ Q2 in 2012

Jointly production by DuPont and Honeywell

June 16 Automotive News

DuPont and **Honeywell** will construct and operate a plant to produce the new refrigerant, HFO-1234yf. The latest pact follows an earlier agreement under which the two companies developed the product.

The product meets the European Union's mandate to reduce the global-warming potential of refrigerants.

By 2017, all new automobiles sold in Europe will be required to use refrigerants with a low global-warming rating. The joint venture will begin supplying the refrigerant in the fourth quarter of 2011

AGRAMKOW

Hybrid electric vehicle

R1234yf

Engine

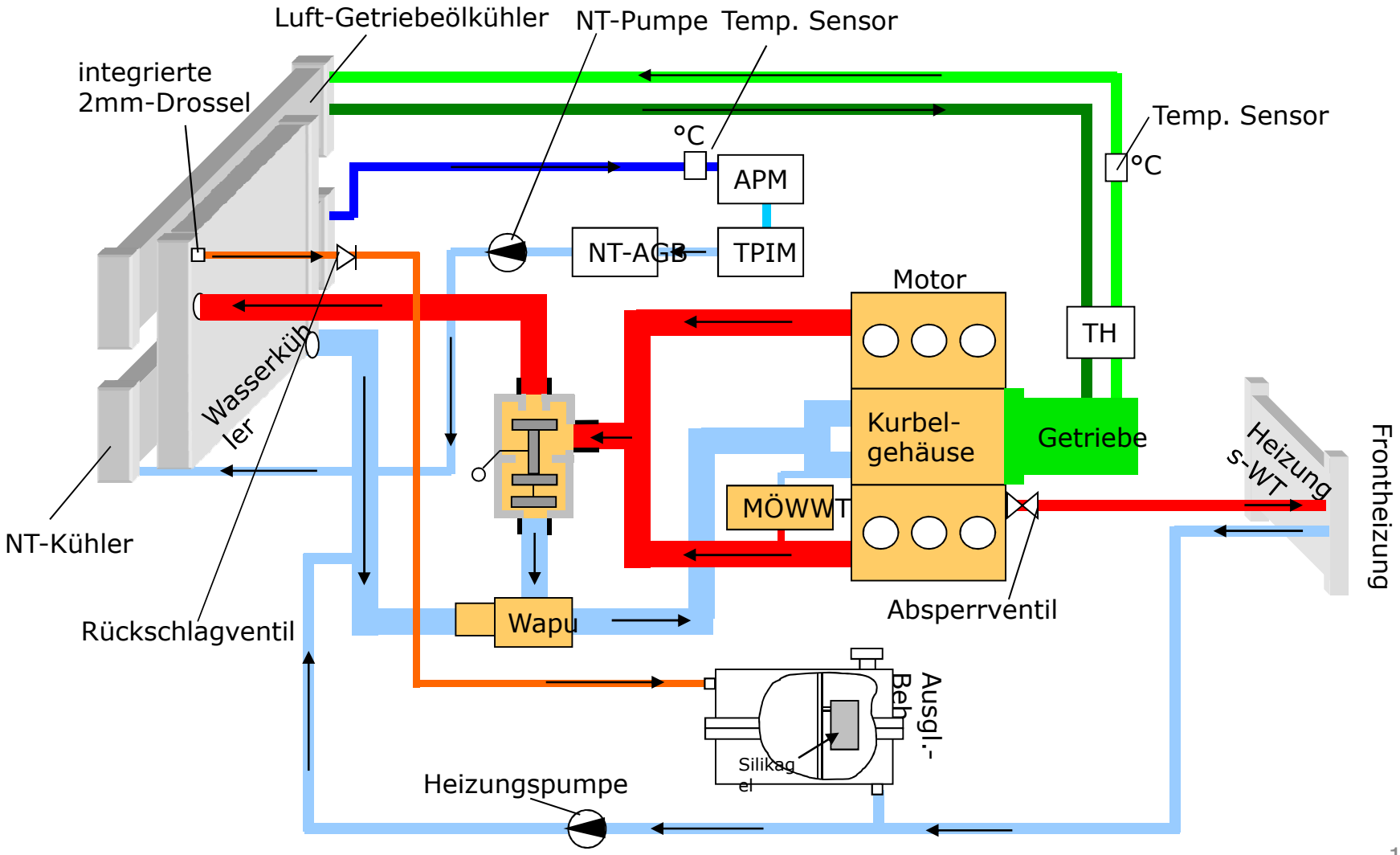
Electronic

Battery

AGRAMKOW

Current Cooling needs

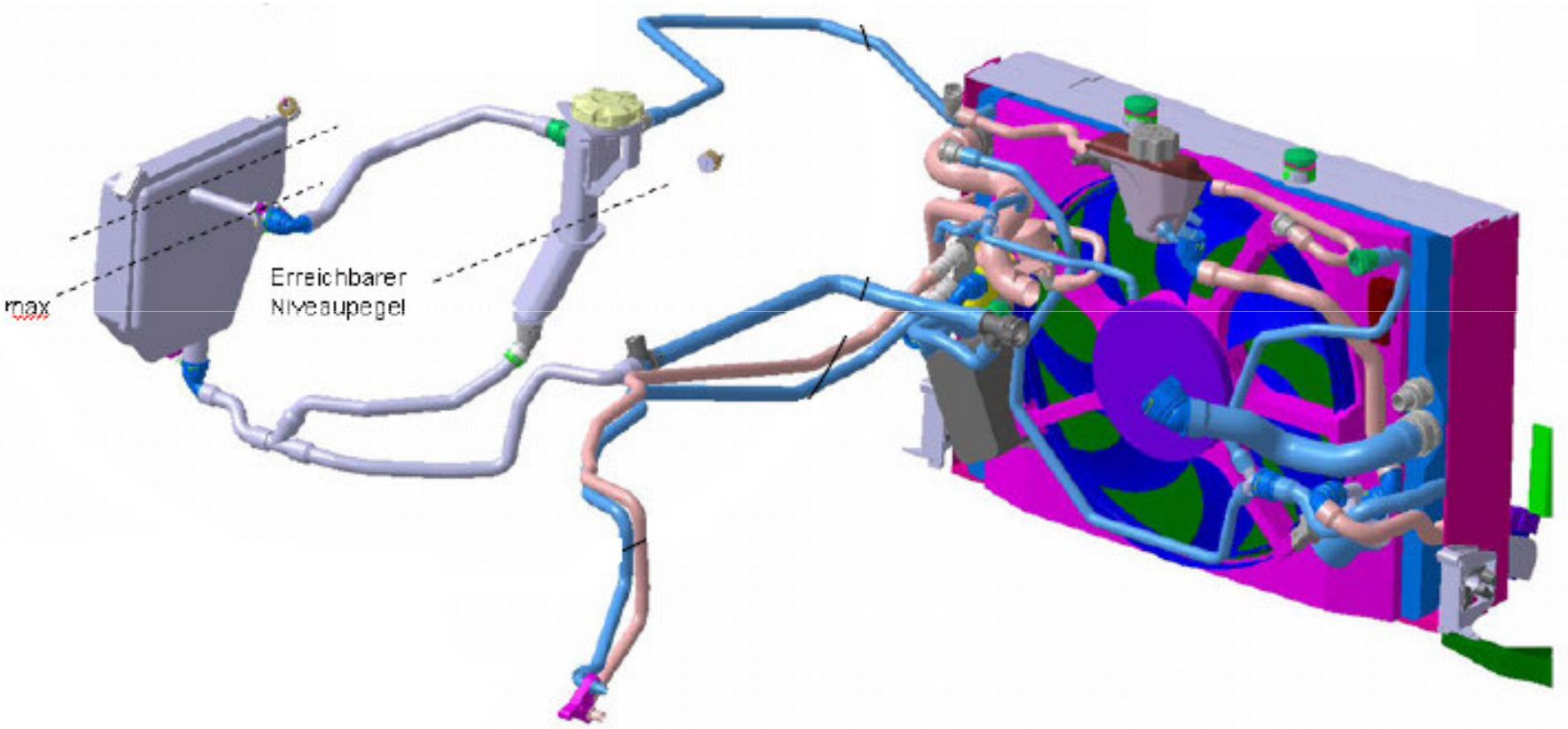
(air-con not illustrated)



AGRAMKOW

Current Cooling needs

(air-con not illustrated)



AGRAMKOW

Future HVAC needs

Can it also be used during winter and summer ??

NOW with Heating and air-con (combustion engine driven)

Animation

AGRAMKOW

The challenge

(The dark horse)

One for all ??

HVAC
(Engine)
Battery
Electronic

R744 or ??

Source IXETIC

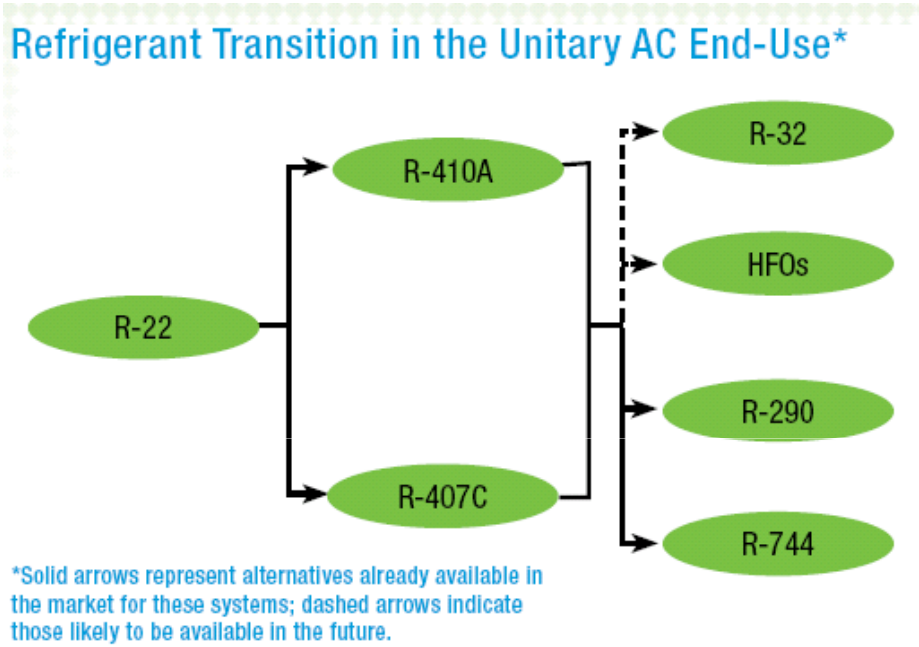
Animation

Animation

AC trends

China's Experience

China manufactures half of the world's 50 million mini-split AC systems annually. It's the largest manufacturer of AC equipment in the developing world. A significant portion of production is for the export market—China supplies nearly 85% of the window, wall, and mini-split AC imports to the United States. While R-22 continues to dominate unitary AC domestically, China manufactures both R-22 and R-410A units. The R-410A units are in high demand as exports to developed countries. China has commercialized room ACs with R-290 and is researching unitary AC products with R-32.



Source EPA

U.S. Environmental Protection Agency
EPA-430-F-10-044 • www.epa.gov • October 2010

HFC Alternatives and Market Trends

Today, most unitary AC systems use HCFC-22. Since 2000, developed countries have been transitioning to R-410A and, to some extent, R-407C. Most developing countries continue to rely on R-22. Currently, R-22 represents approximately 85% (1.2 million tons) of refrigerant stocks in existing unitary AC systems worldwide. Of the units sold today, R-22 accounts for approximately 60%, while R-410A and R-407C account for most of the remainder; propane (R-290) accounts for less than 1%.

On behalf of
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

giz PROKLIMA

PROKLIMA

OEWG 1-5 August Montreal
GIZ Side Event

Gree HC290 Product & Production Acceptance

GIZ Proklima

Montreal, August 2011

Ir. Igor C. Croiset
Linda Ederberg
Zhong Zhifeng - MEPFECO

Source: GIZ homepage

2. Acceptance of the production line

- The panel of experts unanimously expressed their view that the production line is of world class quality and safety aspects have been treated well above the practised standards used in domestic refrigeration!
- GIZ, Gree, Mepfeco and CHEAA received with this acceptance the confirmation of the professional work performed by all parties and together with the TüV certificate a very important consensus.
- Which will open doors to the many air conditioners manufacturers in China as well as having international and local certification procedures.

CERTIFICATE

No. TÜV- IS-UL 1 528 804

This is to certify that

Object: R 290-Charging Plants for Production of Air Conditioner Safety Equipment

Supplier: Agramkow, Fluid Systems A/S DK-6400 Sonderborg

Operator: Gree Electric Appliances Inc. Jinji West Rd.;Zhu Hai, Guangdong; P.R. China

meets the ... of the TÜV SÜD Industrie Service GmbH. It was installed according to the relevant international Standards. The charging plant with Propane as refrigerant has been submitted to an audit to verify compliance with the state of the art. The system was audited in the period from 26th September to 1st October 2010.

This Certification is based on Final Report Safety Inspection of R 290 Charging PLANT Project: GTZ-GREE Propane Charging Plants

TÜV IS-ULM-RvGa
File No. GTZ/GRE-PRC-05/10

This Certification is valid until 30th September 2013

Ulm, 4th December 2010
TÜV SÜD Industrie Service GmbH

K.J. Richardt B. Gassebner

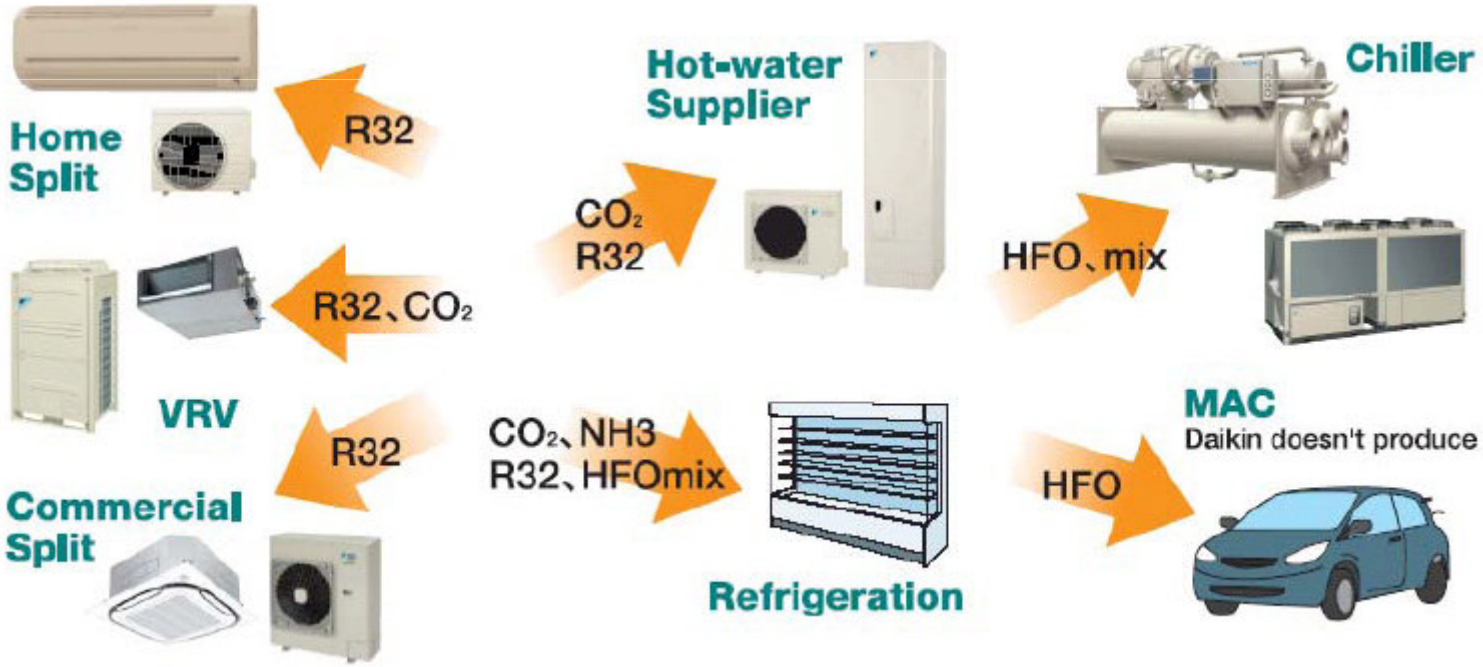
7. Official opening – 14th of July 2011

The Next Generation Refrigerant for Stationary Air-Conditioners and Heat pumps - Daikin's Choice -

August 20th, 2011
Daikin Work Shop in IIR
Daikin Industries, Ltd.

Diversity of refrigerant choice

- GWP value is not the only criterion to consider when selecting an alternative refrigerant. (Energy efficiency, Affordability, Safety, Environmental Load, etc. also must be taken into consideration)
- All refrigerant are included on the table of refrigerant choice
  Choose whatever refrigerant is best suited for each application.
- Daikin is developing R32 split air –conditioners from residential to commercial range because R32 is better suited to these applications



DAIKIN

Selecting Candidates

Refrigerant Candidates for unitary A/C

	Refrigerants		Properties				
			P_{cond} (MPa)	Vol. Cool. Capacity (vs R22)	Theoretical COP (vs R22)	ODP	GWP (IPCC 4th)
	R22	Single	1.73	100	100	0.05	1810
HFC	R407C	Zeotrope	1.86	102	99	0	1770
HFC	R410A	Azeotrope	2.72	141	92	0	2090
HFC	R32	Single	2.80	160	97	0	675
HFC	HFO1234yf	Single	1.16	57	90	0	4
HFC	HFO-Mix	Zeotrope	?	?	?	0	?
Non-HFC	R717 (NH_3)	Single	1.78	116	106	0	0
Non-HFC	R290 (Propane)	Single	1.53	83	98	0	<3
Non-HFC	R744 (CO_2)	Single	10	243	41	0	1

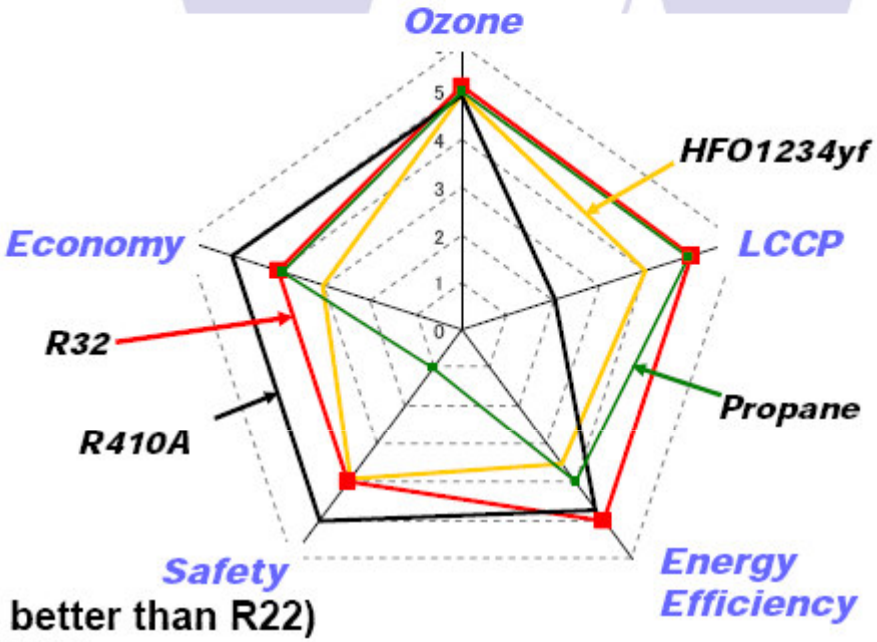
Candidates for the next generation working fluids

August 20th, 2011 Daikin Industries, Ltd.

DAIKIN

Comprehensive Comparison

R32 is the most balanced and feasible alternative



Characteristics of R32

- Zero ODP
- Superior Energy Efficiency (10% better than R22)
- Small Global Warming Impact (LCCP)
- Small Conversion Cost (almost same as conversion to R410A)
- Acceptably Flammable (Class A2L)
- Supply capability is sufficient (50% of R410A is R32. Suppliers exist now)
- Easy to recycle (single component)
- R32 can be introduced quickly when taking into account the total life cycle: production, equipment manuf., use, installation/maintenance, recovery, and end of life.

August 20th, 2011 Daikin Industries, Ltd.

US status

Acceptable Substitutes for Class II (HCFCs) Substances in Air Conditioning and Refrigeration under the Significant New Alternatives Policy (SNAP) Program as of March 29, 2011

Substitutes (Name Used in Federal Register)	Trade Name	Household and Light Commercial AC	Commercial Comfort AC	Industrial Process Refriger-ation	Industrial Process AC	Bus and Passenger Train AC	Cold Storage Warehouse Systems	Ice Skating Rinks	Refriger-ated Transport	Retail Food Refriger-ation	Ice Machines	Very Low Temp Refriger-ation	Household Refrigerators and Freezers	Other Refrigerated Appliances
R-290 (Propane)				R, N										
R-407B				R, N			R, N	R, N	R, N	R, N	R, N			
R-407D									R, N					
R-600 (Butane)				R, N										
R-1270 (Propane)				R, N										
Cryogenic system using recaptured liquid CO2 or liquid N2									N					

R = Retrofit Uses, N = New Uses,

In response to the increased interest in HC refrigerants, the EPA issued a Notice of Proposed Rulemaking (NPRM) in the U.S. *Federal Register* in May 2010. The NPRM recommends that "isobutane, propane, HCR–188C[28] and HCR–188C1 be acceptable, subject to use conditions, as substitutes for R–12 and R–22 in household refrigerators, freezers, and combination refrigerator and freezers and commercial refrigeration (retail food refrigerators and freezers—stand-alone units only").[29]

Source

Environmental Protection Agency
Air and Radiation Stratospheric Protection Division
6205J

Substitute Refrigerants Under SNAP as of March 29, 2011

AGRAMKOW

But, they are pushing..

GE unveils first HFC-free household refrigerator; Awaiting hydrocarbon refrigerant approval from EPA

LOUISVILLE, Ky. — (NYSE: GE) — GE has taken a leadership role so that U.S. families might enjoy cleaner refrigeration in their homes, empowering citizens to reduce greenhouse gas emissions while still enjoying all the benefits and features consumers demand of 21st century refrigerators.

The announcement comes as the company awaits a final rule from the Environmental Protection Agency (EPA) in connection with its request for approval to use isobutane as a refrigerant in household refrigerators. GE had originally filed a petition under the Significant New Alternatives Policy (SNAP)* program, which evaluates alternatives to substances being phased out under the Clean Air Act for protection of the stratospheric ozone layer. In response, EPA has issued a proposed rule approving isobutane for use in household refrigerators, subject to certain use conditions.

Source: GE homepage

AGRAMKOW

Coca-cola

CO2

We’ve identified a natural refrigerant gas to replace HFC refrigerant gas and are phasing out the use of HFCs in all new equipment by 2015.

R290

Source: Coca-Cola homepage

AGRAMKOW

A good story at the end

VAT discount by environmental R134a > R600a conversion

Cooling and heating issues always
generates new solutions/options

Thanks for your attention