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Increased energy and resource efficiency for air conditioner and heat pump system using R32 as refrigerant

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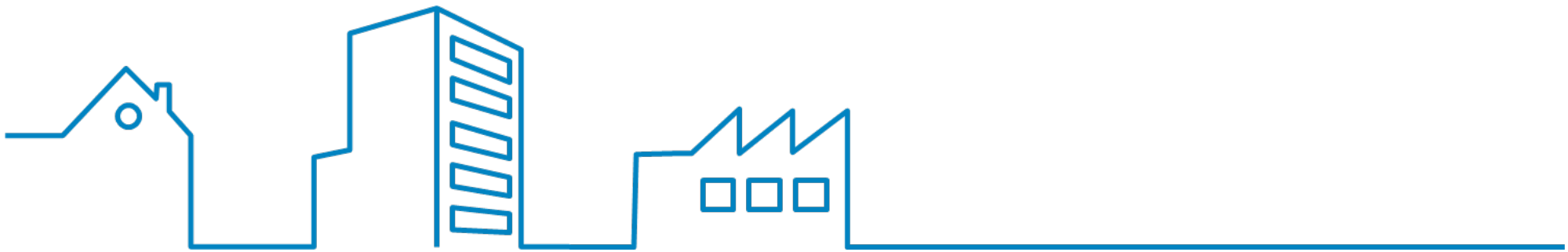


The energy & climate change challenge: Role of the heating & cooling industry

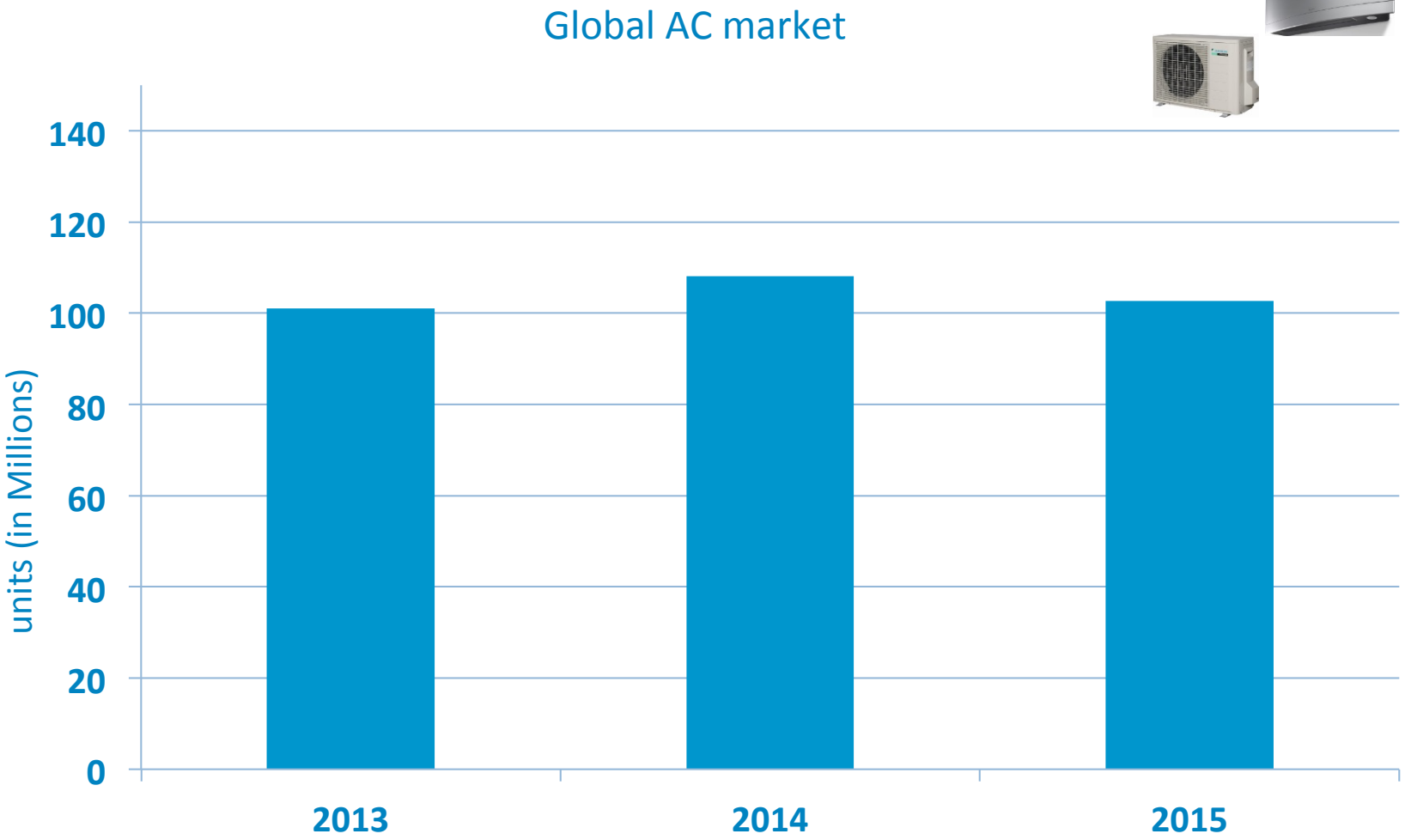
Heating and cooling play a major role in the energy and climate change impact of countries.

For example, in EU heating and cooling represents around half of the EU energy consumption. More than two thirds of heating and cooling (84%) is still generated from fossil fuels; only around 16% is generated from renewable energy.

Products coping with the demand of heating and cooling are mainly products from industrial manufacturing.

Source : EU Commission - the contribution from heating and cooling to realising the EU's energy and climate objectives
http://ec.europa.eu/smart-regulation/roadmaps/docs/2015_ener_026_heating_cooling_strategy_en.pdf

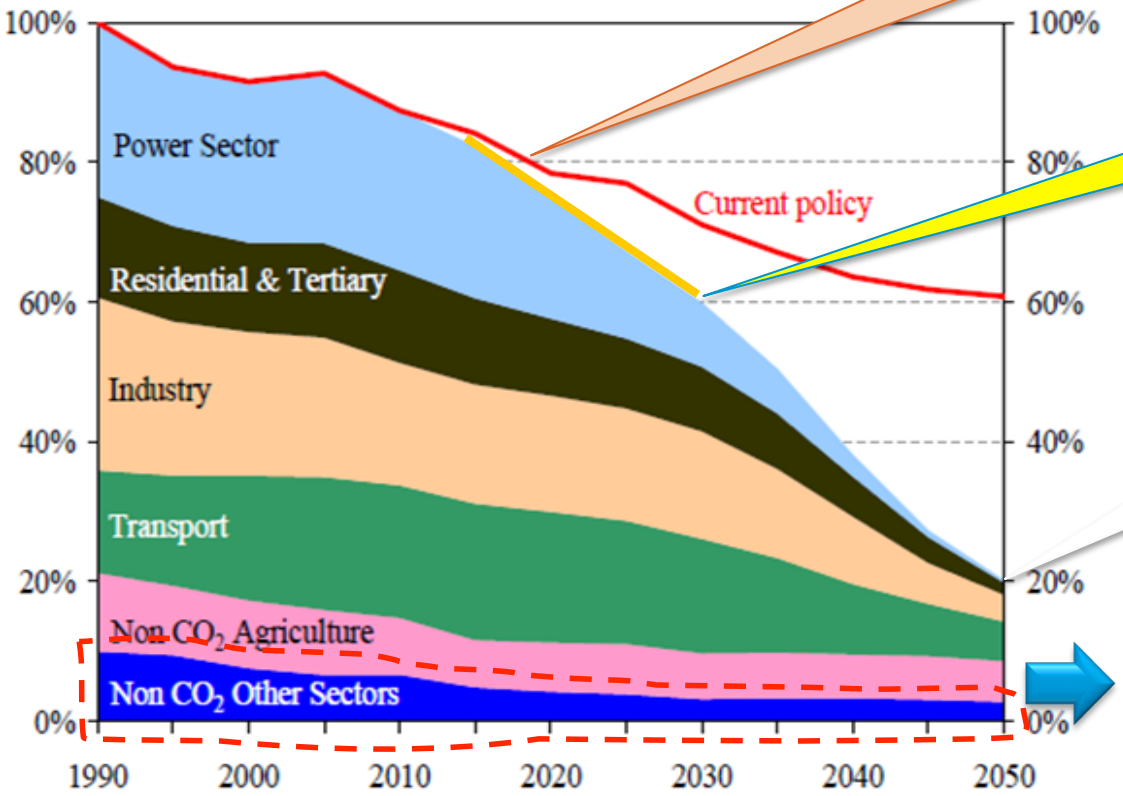
Global demand on air conditioners - impact on energy and resource efficiency



Global car market 2015: 72 million cars

EU targets to reduce greenhouse gas emissions

Targets will be mostly achieved by the change of electricity generation & increased energy efficiency. For example, emissions from houses and office buildings need to be cut by **around 90%** in 2050



20% reduction by 2020

- 40% reduction by 2030

80% reduction by 2050

Fluorinated greenhouse gases such as HFCs used as refrigerants in air conditioners and heat pumps belong to the group of "non CO_2 other sectors"

Source: EU low carbon roadmap 2050

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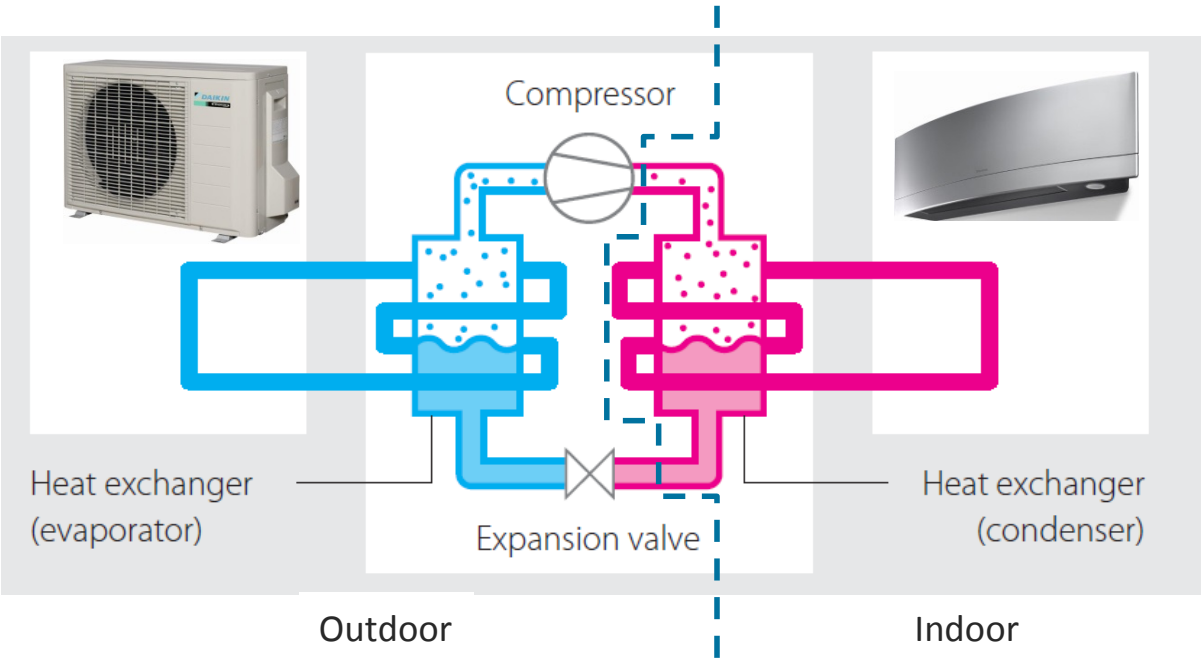
Principle of a heat pump

Task of the refrigerant: Heat transfer

Based upon the refrigerant, the components are designed



Core element of a refrigerant circuit – the refrigerant

Key considerations for refrigerant choice:

- Safety
  - Safe through the entire lifecycle
- Environmental impact
  - Heat transfer capacity
  - Potential for recycling and reuse
- Energy Efficiency
  - Potential to improve the energy efficiency in cooling and heating function
- Cost effectiveness
  - Affordable solutions for customers homes and businesses

Core element of a refrigerant circuit – the refrigerant

Major refrigerant properties

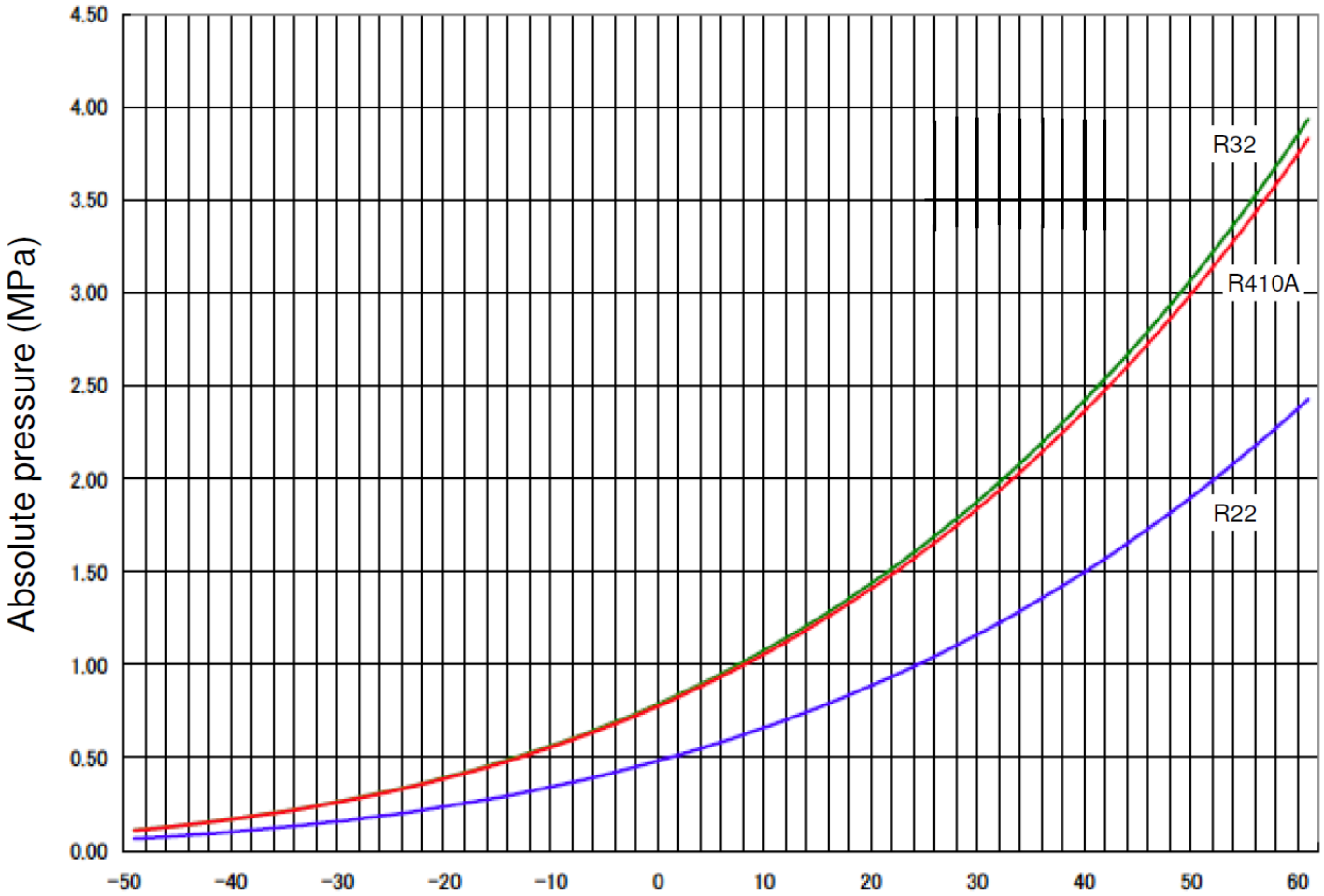
Product		HFC-32	R-410A	HCFC-22
Component		HFC-32	HFC-32/HFC-125	HCFC-22
Chemical formula		CH_2F_2	CH_2F_2/CHF_2CF_3	$CHClF_2$
Composition	mass%	100	50/50	100
Critical temperature	℃	78.1	72.0	96.2
Boiling point	℃	−51.7	−51.4	−40.8
Density Saturated liquid	kg/m³	961	1059	1191
Saturated vapor	kg/m³	47.34	64.87	44.23
Viscosity Saturated liquid	mPa·s	0.116	0.121	0.178
Normal pressure vapor	mPa·s	0.0126	0.0129	0.0128
Isobaric specific heat Saturated liquid	kJ/kg·K	1.937	1.711	1.256
Normal pressure vapor	kJ/kg·K	0.848	0.818	0.662
Latent heat of vaporization (Boiling Point)	kJ/kg	382	275	233
Ozone depletion potential (ODP)	CFC11=1	0	0	0.055
Global warming potential (GWP) *1	CO_2=1	675	2088	1810
Solubility of water	massppm	3400	1600	1300

Unless otherwise specified, the values in the above table are at 25℃.

*1 Global Warming Potential: Based on IPCC 4th Assessment Report 2007, integration time horizon 100 years. For blends, figures calculated on its basis.

Core element of a refrigerant circuit – the refrigerant

Saturated Vapour pressure / Temperature curves



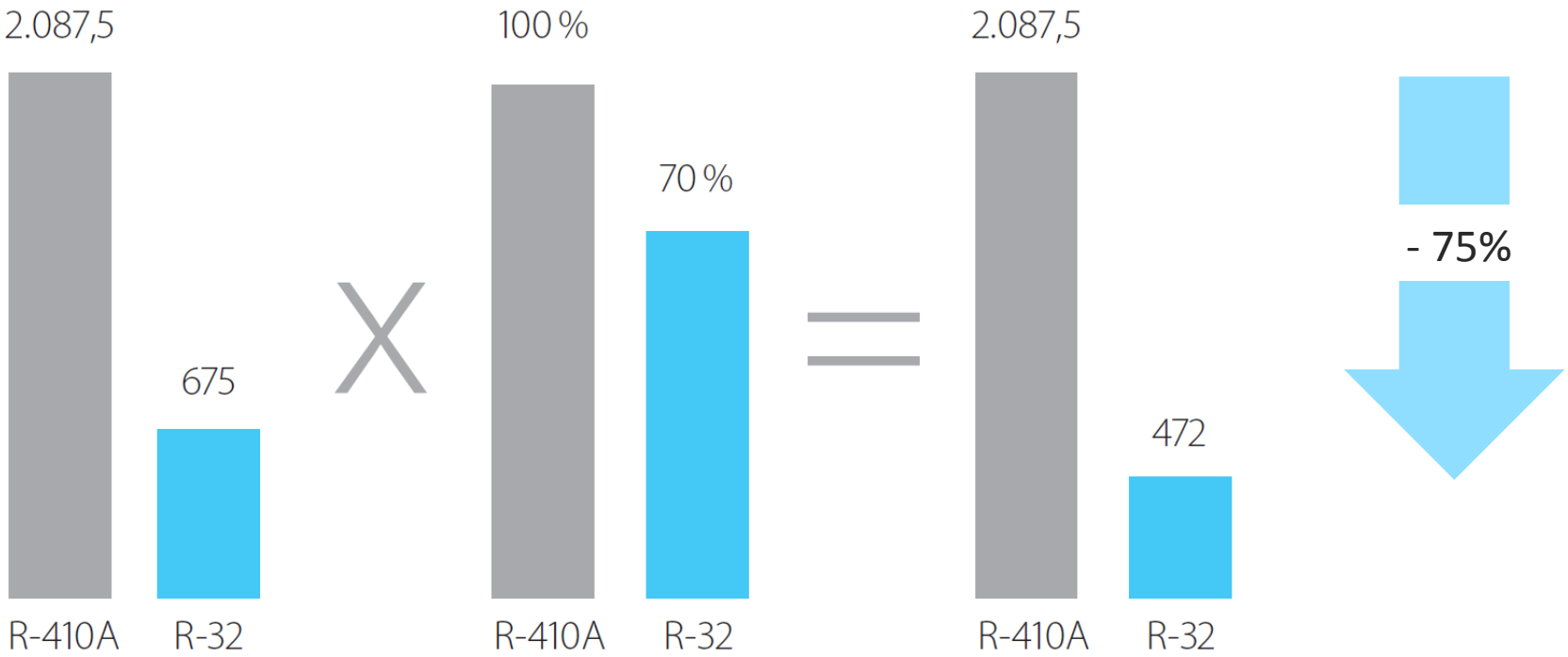
Core element of a refrigerant circuit – the refrigerant

Flammability classification

Refrigerant	HFC-32	R-410A	HCFC-22
ASHRAE standerd 34	Class 2L (Slightly flammable)	Class 1 (Non-flammable)	Class 1 (Non-flammable)
ISO international standard 817	Class 2L (Slightly flammable)	Class 1 (Non-flammable)	Class 1 (Non-flammable)

Benefits of using R32 refrigerant

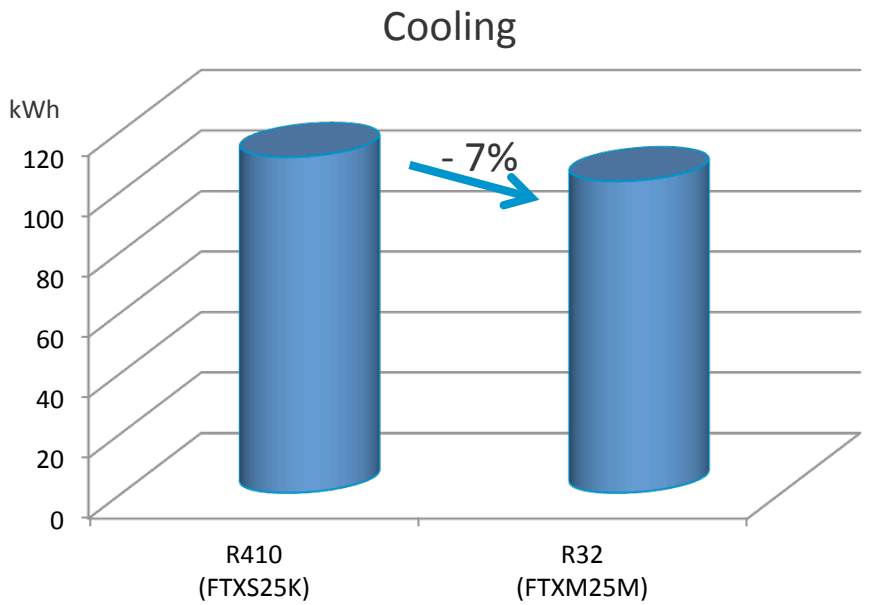
Increased resource efficiency and reduced environmental impact

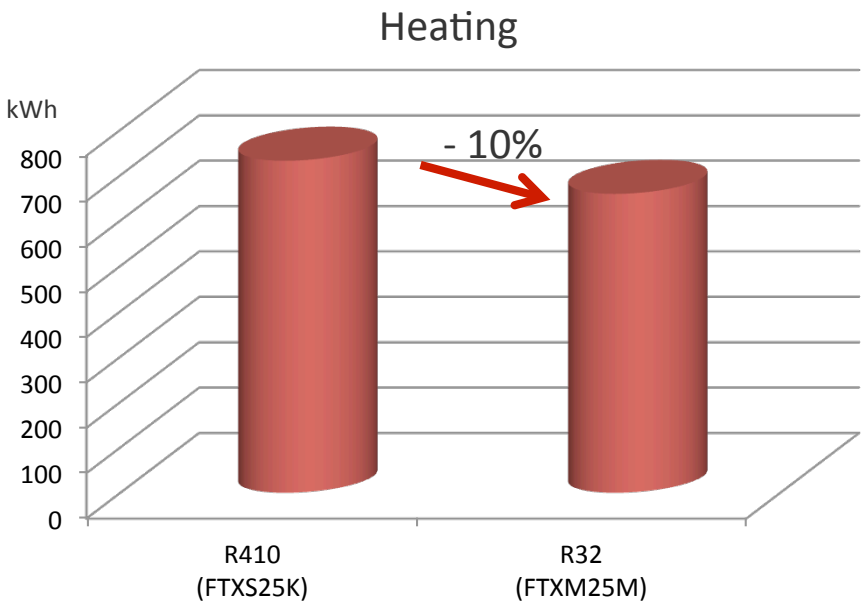


Benefits of using R32 refrigerant

Increased energy efficiency

Annual energy consumption based on ERP data





Summary

- The choice of the refrigerant has major impact on air conditioning and heat pump products in terms of
  - Energy efficiency
  - Resource efficiency
- It is the responsibility of the heating and cooling industry to reduce its environmental impact by replacing current refrigerants with those having less environmental impact.
- Using R32 single component refrigerant for air-conditioning and heat pump equipment encourages the global industry to grow responsibly as well as meet rising demand.
- The avoided carbon emission benefits of a global transition to R32 would be very significant.

Thank you