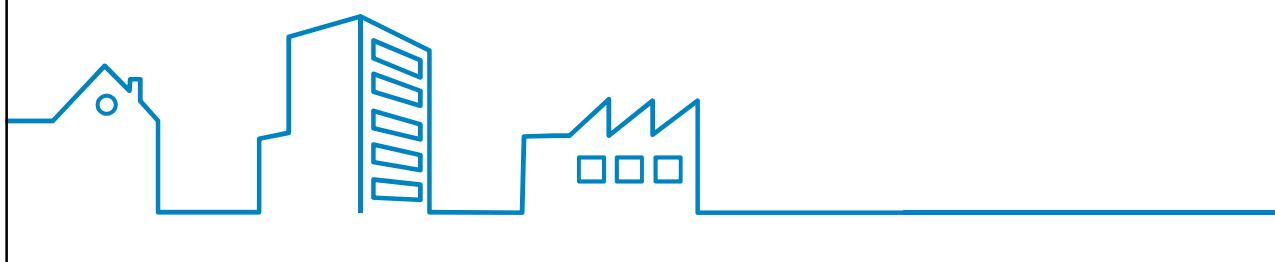




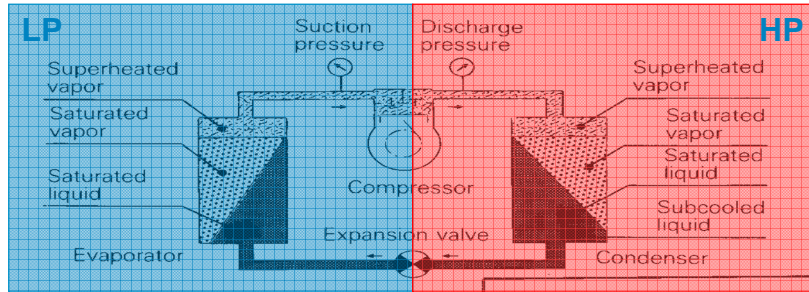
Refrigerants & Cooling in renovation buildings



01 Basics Refrigeration circuit.

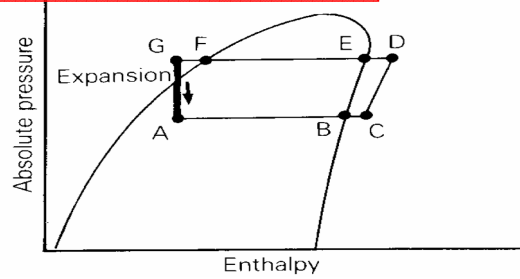


Refrigeration Basics

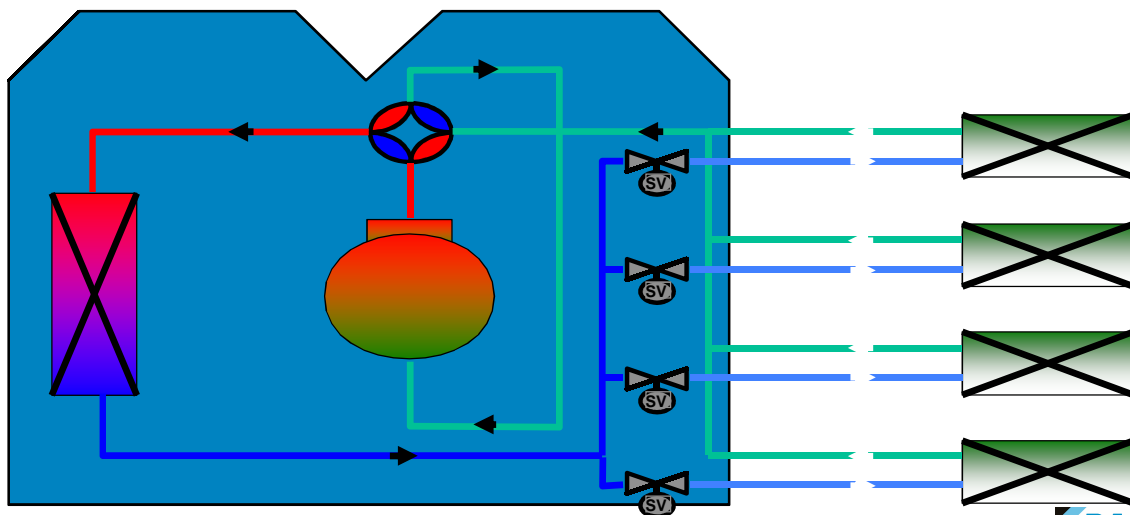


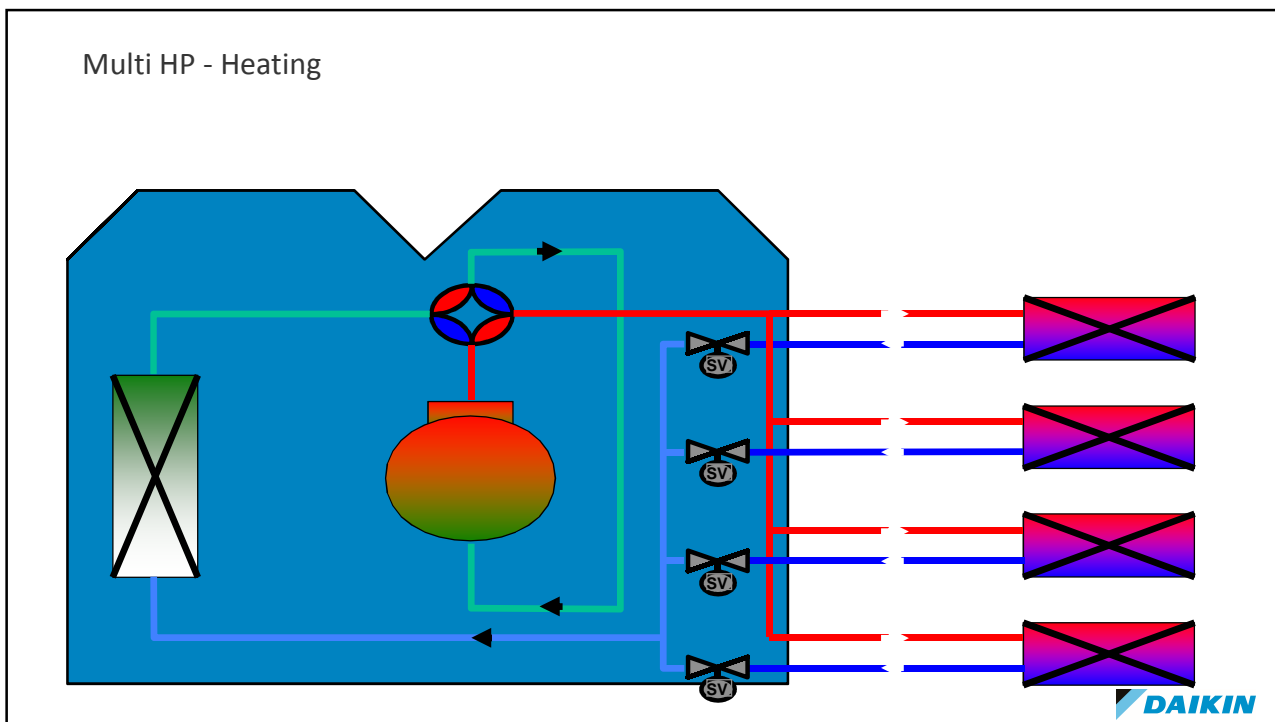
Mollier Diagram

- A-C Evaporation
- B-C Superheat
- C-D Compression
- D-E Desuperheat
- D-G Condensation
- F-G Subcooling



Multi HP - Cooling





02 Refrigeration

Question!



From all worldwide greenhouse gas emissions, how much % is due to emissions of **HFCs**?

- A. 0,2 %
- B. 2%
- C. 20%



Question!



From all worldwide greenhouse gas emissions, how much % is due to **ENERGY** ?

- A. 15 %
- B. 25%
- C. 35%

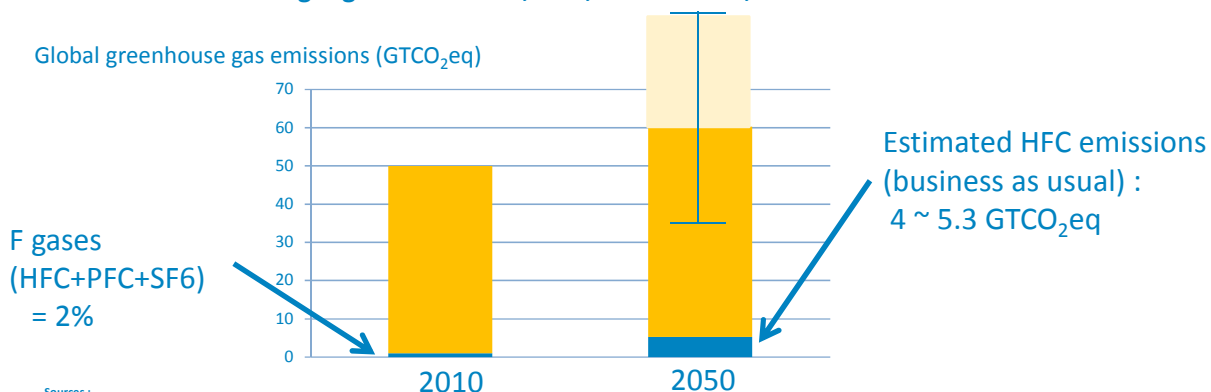


Why Daikin takes actions on refrigerants ?

The current impact of HFC emissions on global warming is small but increasing.

The main HFC use sectors are refrigeration (40~58%) and air conditioning (21 ~40%)

The main HFC consuming regions are China, USA, Middle East , Asia



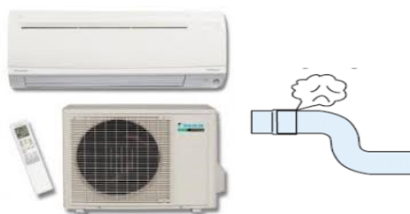
Sources :

- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland
- Future and climate forcings from scenarios of global and regional hydrofluorocarbon (HFC) emissions, Guus J.M. Velders et al., October 2015
- (*) 60 GtCO₂eq in 2050 = SSP3 scenario → values of different scenarios vary between 30 to 100 GtCO₂eq



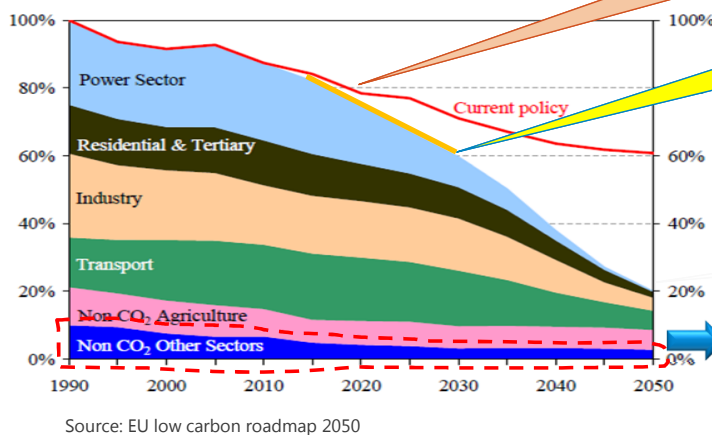
What are "F gases" ?

- HFCs, PFCs and SF₆ are "F gases" = fluorinated greenhouse gases.
- They do not deplete the ozone layer, but account for 2% of the overall EU greenhouse gas emissions.
- Nearly 80% of F gas emissions are due to the emissions of HFCs used as refrigerants in air conditioners, heat pumps and refrigeration products



EU targets to reduce greenhouse gas emissions

Targets will be mostly achieved by the change of electricity generation & by reducing energy consumption. However also other sectors need to contribute.



EU 20-20-20 policy
 • 20% reduction by 2020

NEW EU agreement for 2030
 • 40% reduction by 2030

EU low carbon roadmap 2050
 80% reduction by 2050

F gases such as HFCs used in our air conditioners and heat pumps belong to the group of “non CO2 other sectors”



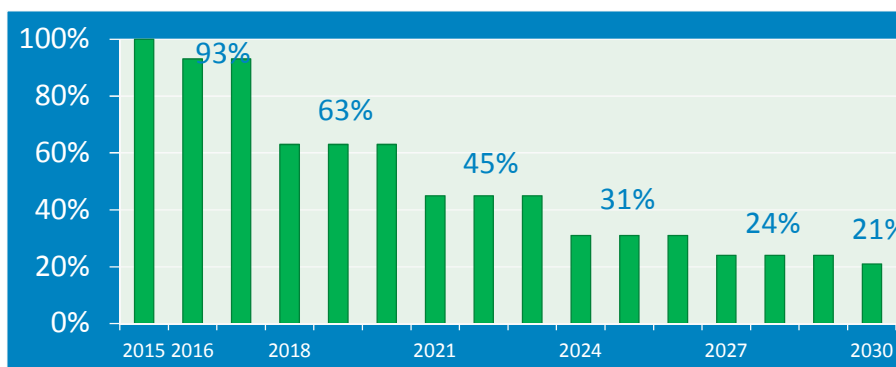
The HFC phase-down schedule

Main principles:

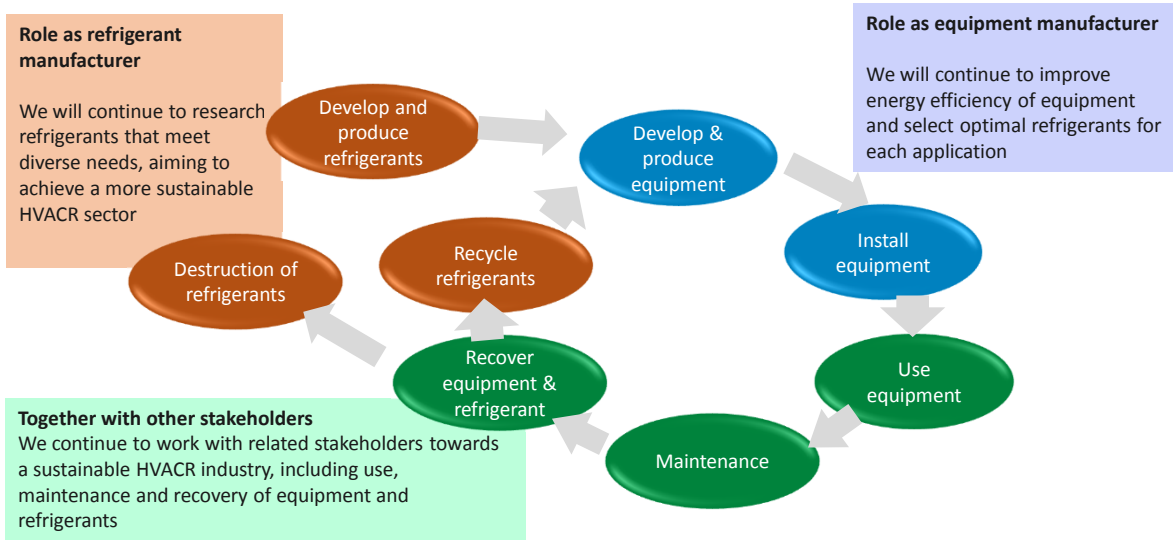
1. Quota are in CO2 equivalent (kg x GWP value)
2. Quota are imposed from 2015 onwards on the bulk HFC producers or importers that place HFCs on the EU market for the “first” time
 → push on the suppliers will trigger the users to go for alternative solutions



Year	Reduction by
2009-2012	Baseline
2015	100% (Freeze)
2016-17	93%
2018-20	63%
2021-23	45%
2024-26	31%
2027-29	24%
2030	21%



Towards a sustainable refrigerant & equipment lifecycle

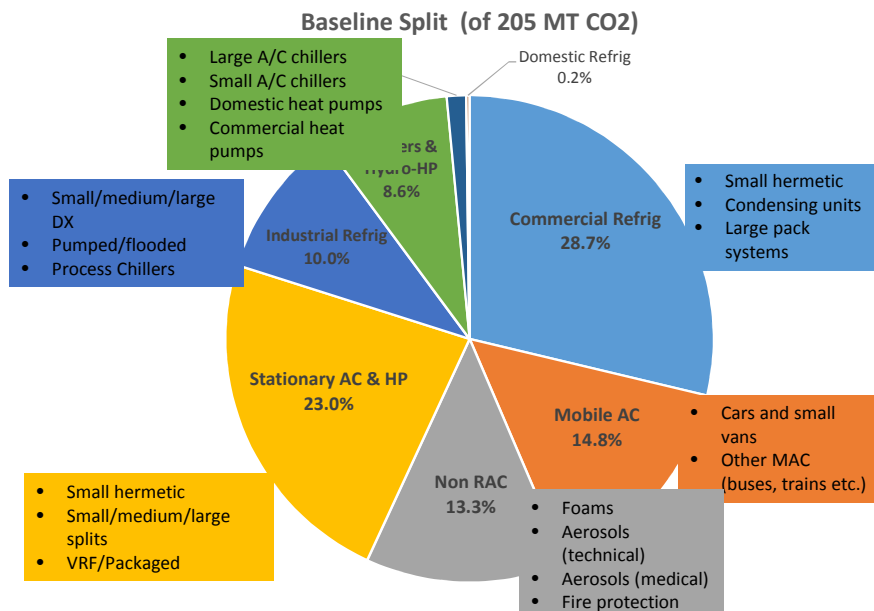


Daikin refrigerant direction – key considerations

- ✓ At Daikin we assess 4 basic factors when making a refrigerant choice for a product application :



Drivers of HFC Demand: the 8 Main Market sectors



Remember :

- A “phase down” is not a “phase out” !

A phase down is based on $\text{CO}_2\text{eq} = \text{GWP} \times \text{kg}$

It can be achieved by a combination of :



- **lower GWP** : Changing refrigerant type
- **less kg** :
 - Reducing refrigerant charge amount
 - Minimizing leakage
 - Increasing Recovery & reuse

- The future will be based on a wide diversity of refrigerants (HFC, HFO, blends, natural refrigerants)
→ there is no “one-size-fits-all” solution



New F gas regulation : additional
GWP limits for air conditioners & heat pumps

GWP limitations

For portable AC : GWP
must be **<150**
from 2020



🚫 R410A : Not OK

👍 R290 : OK

For SINGLE split air conditioners with a
charge BELOW 3 kg : GWP must be **<750**
from 2025



🚫 R410A : Not OK

👍 R32 : OK

DAIKIN

New F gas regulation : additional GWP limits
on refrigeration products

- Service ban on existing refrigeration systems with charge of > 40TCO₂eq :
GWP must be <2500 (new gas 2020, recycled/reclaimed gas 2030)
- In all new stationary refrigeration GWP must be <2500 from 2020
- More strict GWP limits on :
 - Residential & commercial fridges & freezers (GWP<150) (2020/2022)
 - Multipack supermarket systems >40kW (GWP<150 or cascade
GWP<1500+GWP<150) (2022)

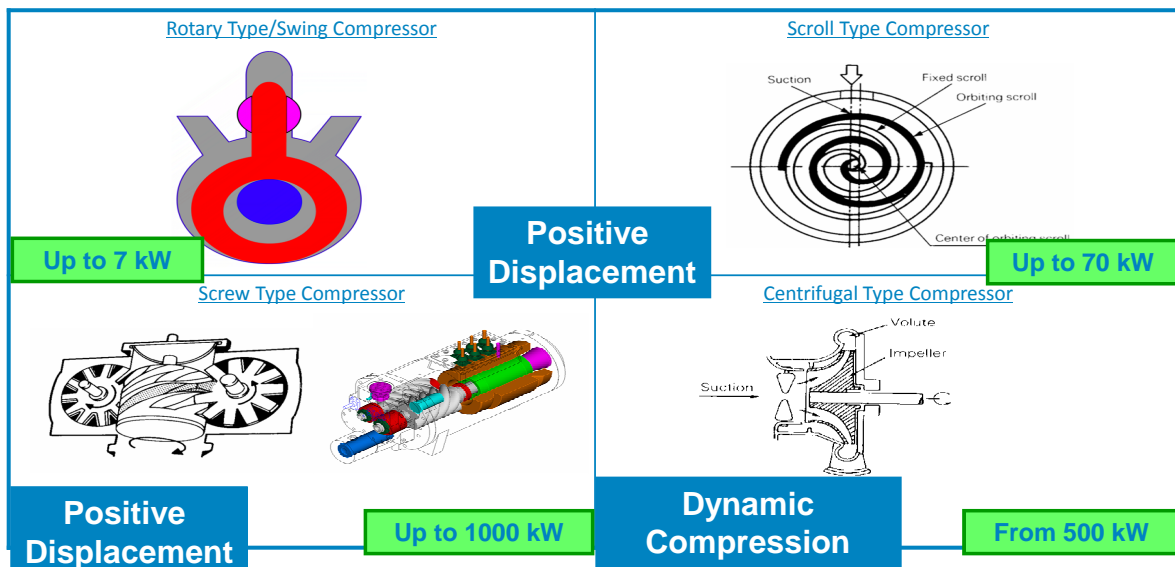


DAIKIN

			Refrigerant physical properties					
			Cond.Press. MPa	ODP	GWP (IPCC4)	Life Year	Flammability	Toxicity
R22		Single	1.73	0.05	1810	11.9	No	Low
HFC	R410A	Azeotrope	2.72	0	2090	5-29	No	Low
	R407C	Zeotrope	1.86	0	1770	5-29	No	Low
	R32	Single	2.80	0	675	5	Low*1	Low
	HFO1234ze	Single	0.88	0	6	11 days	Low*1	Low*3
	HFO1234yf	Single	1.16	0	4	7 days	Low*1	Low*3
	HFO mixture		Under investigation					Low
Non-HFC	Propane (R290)	Single	1.53	0	<3	Some days	High	Low
	CO2(R744)	Single	10.0	0	1	120	No	Low*2
	Ammonia (R717)	Single	1.78	0	0	0	Low	High



4 Types of Compressors Used



Daikin refrigerant direction – by product segment

Including Zanotti , J&E Hall



	Today	Status
Air conditioners & heat pumps	R410A → R32	R32 product portfolio expanding since 2012
Chillers & Air side equipment	R410A, R134a, Ammonia	Under investigation : R32, HFO, blends
Refrigeration	R404A, R410A, R134a, R448a, R449a, CO2, Ammonia, HC : R290, R600a	Under investigation : R407H, R32, HFO
Marine containers	R134a	Under investigation : R32, HFO, R513
AC & Refrigeration for vessels	R404A → R407C	R407C completed Under investigation : R407H & others
Truck & Trailer refrigeration	R404A, R452A	Lower GWP under investigation

21

some markets have “ultra-low” GWP options available, e.g.:

car air-conditioning	HFO-1234yf	GWP = 3
domestic refrigerators	HC-600a	GWP = 4
large retail refrigeration	R-744 (CO ₂)	GWP = 1
water chillers for large AC	HFO-1234ze	GWP = 7

DX air-conditioning market more difficult

no ultra-low GWP option currently available

HFC-32 is a good “moderate” GWP option for smaller systems (GWP = 675)

approx. 75% reduction in tonnes CO₂ (taking into account reduced GWP and charge)

but limitations on maximum charge due to A2L “lower flammability” rating

R-410A still a good option for larger DX systems e.g. VRF

2030 phase-down target will be met with a “mix” of many refrigerants

ultra-low GWP refrigerants in many markets

car AC, commercial refrigeration, AC water chillers

HFC-32 and other moderate GWP refrigerants in some markets

including smaller DX AC

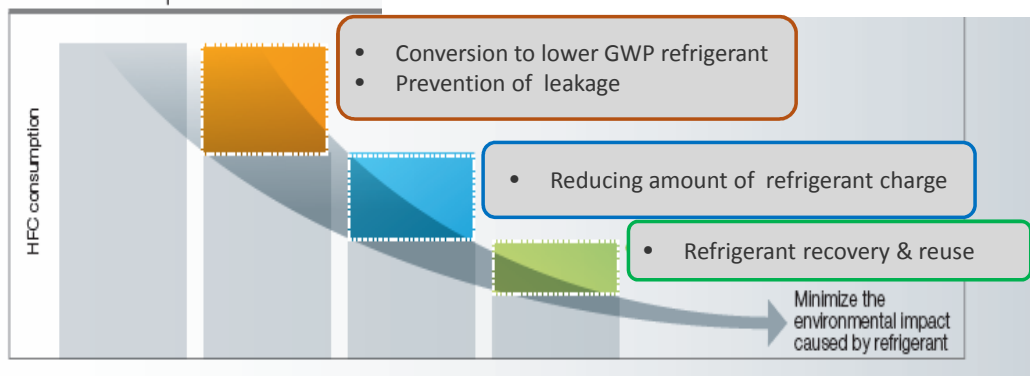
R-410A in larger DX AC systems that require a non-flammable refrigerant

e.g. VRF systems



Daikin comprehensive approach towards an HFC phase down

Comprehensive approaches
toward HFC phase down



There is no “one-size-fits all” refrigerant

- Each manufacturer needs to make choices depending on the application and the needs of the market & taking into account energy efficiency, safety, affordability, local legislations & standards.
- Daikin is developing R32 split air –conditioners from residential to commercial range because R32 is suitable for these applications



Cooling in Renovation 03 Buildings

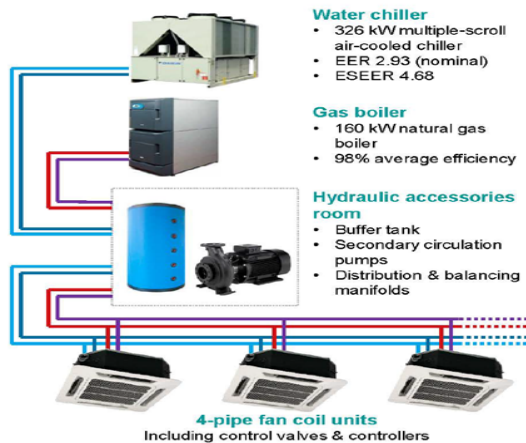
W. CHILLER vs VRV MAIN SOLUTIONS AVAILABLE:



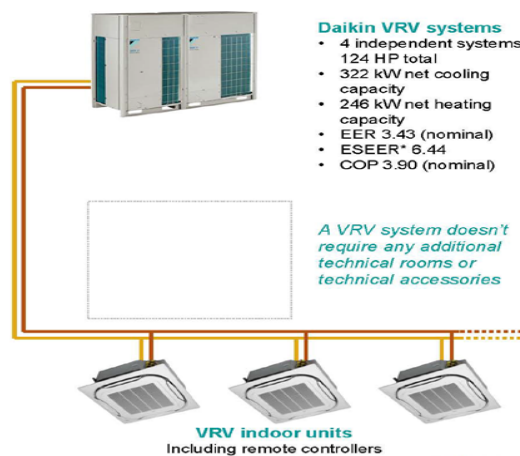
Total life cycle cost comparison

Solutions

TRADITIONAL

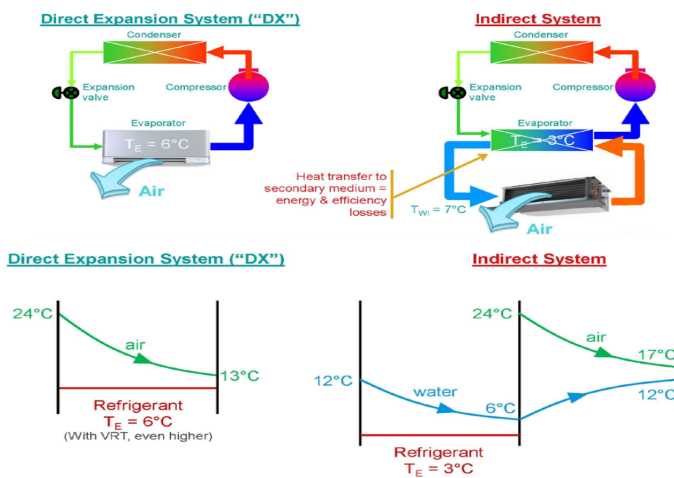


VRV



HIGHER EFFICIENCY

- Direct expansion is well known to be more efficient than traditional chillers for small and medium capacities (>300kW)



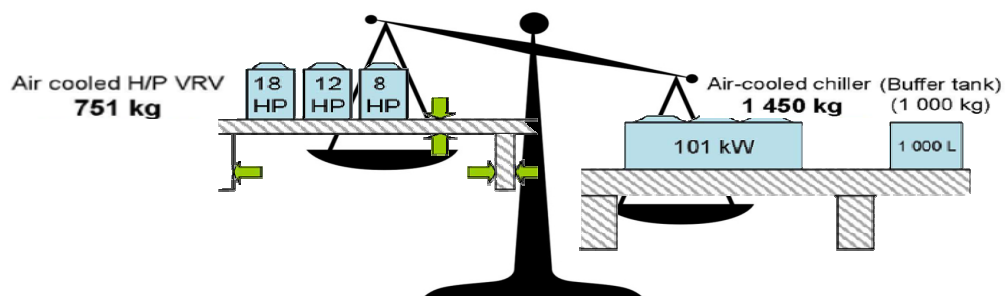
SMALL PIPES

- Refrigerant pipes are quite smaller compared to air ducts or water pipes, because DX takes advantages of latent heat.



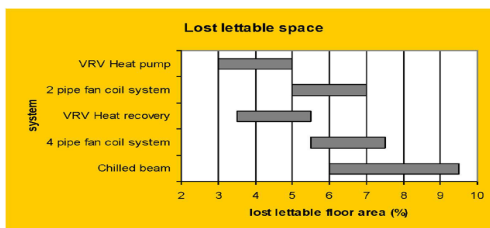
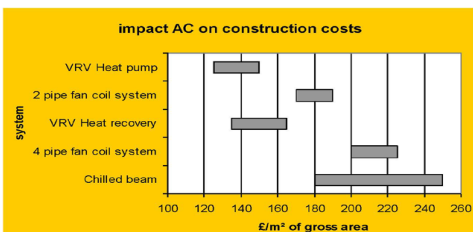
LESS FOOTPRINT AND WEIGHT

- VRV systems are less heavy so there is no need of structure reinforcement
- VRV units are even more compact and their installation is more flexible



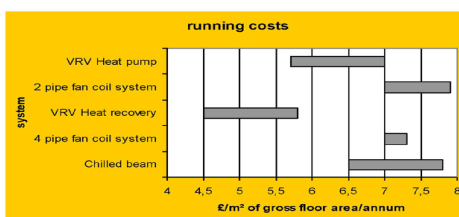
CHEAP SOLUTION

➤ Small footprint gives the opportunity to increase the business



Source: UK Construction Benchmarks Property (2004), Franklin Andrews

➤ Easy installation has a low impact on construction costs



Source: UK Construction Benchmarks Property (2004), Franklin Andrews

➤ High efficiency has a positive impact on running costs



VRV IV TECHNOLOGY

A step forward towards more efficiency and compactness...

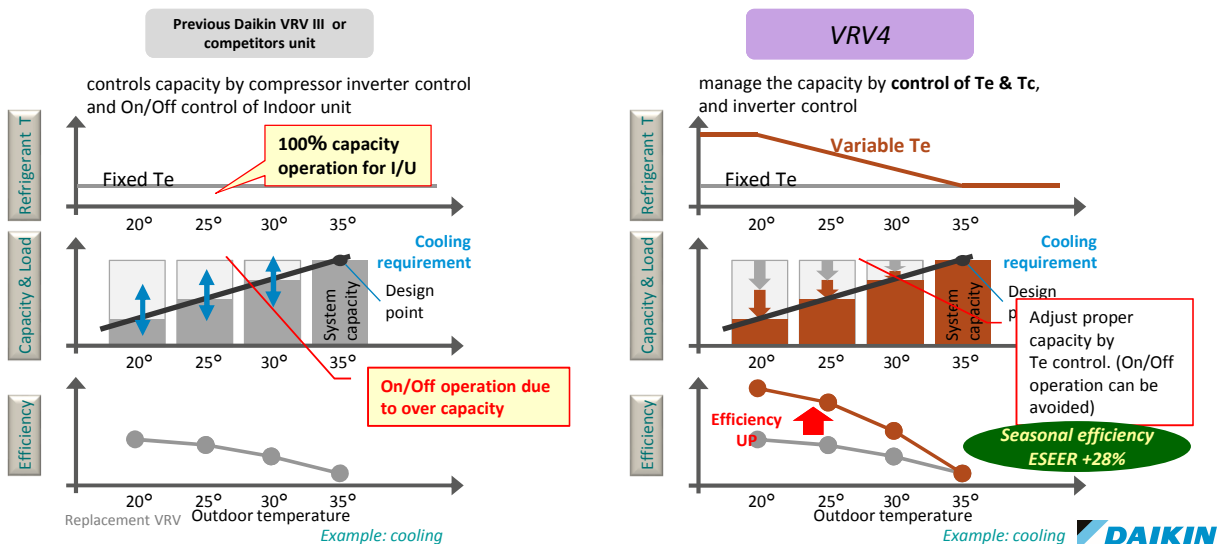


- VRT
- INVERTER COMPRESSOR
- DC FAN MOTOR
- HEAT EXCHANGER



VRT control for energy saving in partial load condition

- Conventional VRF controls capacity by compressor inverter control and On/Off control of Indoor unit.
- VRT can manage the capacity by control of T_e and T_c in order to achieve high seasonal efficiency.



VRV SYSTEMS. Plug and Play Total Solution

- ✓ More efficient, especially in comparison with air cooled chiller
- ✓ Payback period of 3-4 years
- ✓ Easy and fast selection, design and installation
- ✓ Less noisy outdoor units and small footprint
- ✓ Small pipes diameters
- ✓ No need for water treatment
- ✓ Plug and play total HVAC solution
- ✓ Suitable solution for any small and medium commercial application
- ✓ Addressing big commercial application by using water cooled VRV



Thank you