

Natural refrigerants

International Research
Ship Operators

September 2025



Natural refrigerants

International Research Ship Operators

September 2025



Jan Nordvik

Key Account Manager
jan.nordvik@teknotherm.no

Bjørn Holo

Senior Technical Advisor
bjorn.holo@teknotherm.no



Why is this an issue?

Refrigerant leaks from air conditioning in the world marine fleet:

31 000 ton yearly*

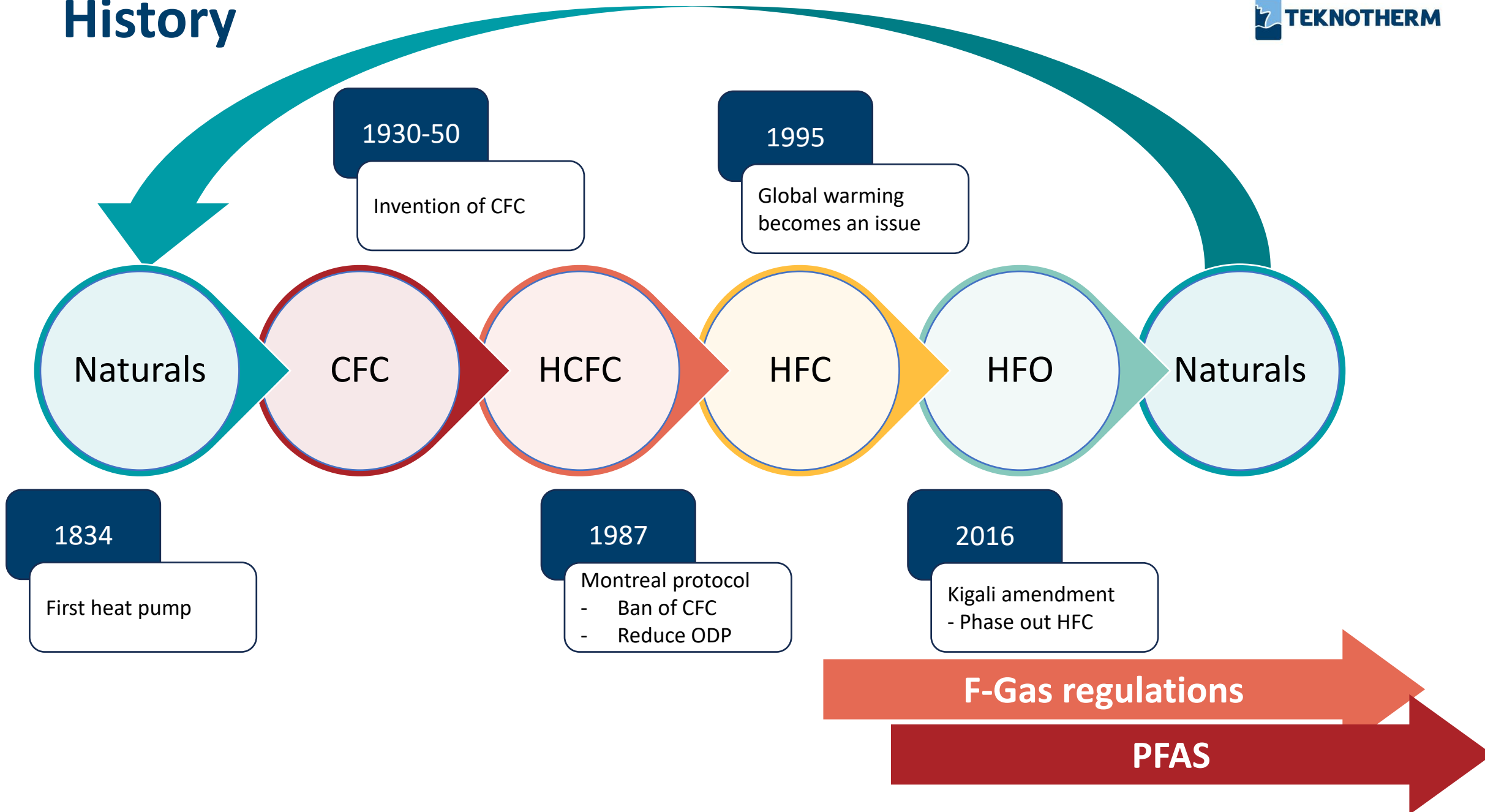
- Ozon depletion
- Global warming
- Degradation products

Agenda

- History and regulations
- Practical measures / design implementation
- References



History



Synthetic refrigerants

1930 – 1980 **CFC** (ChloroFluoroCarbons)

R-11, R-12 “Freon”

- “Safe refrigerants”
- Effect on ozone the layer (ODP)

1980 – 2000 **HCFC** (HydroChloroFluoroCarbons) R-22, R-123

- Reduced ODP
- Effect on global warming (GWP)

1990 – ? **HFC** (HydroFluoroCarbons)

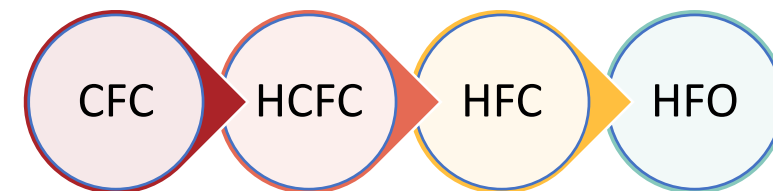
R-134a, R-410a, R-513a

- No ODP
- Effect on global warming (GWP)

2000 – ? **HFO** (HydroFluoroOlefin)

R-1234yf, R-1234ze, R-513a

- No ODP
- Very low GWP
- Slightly flammable



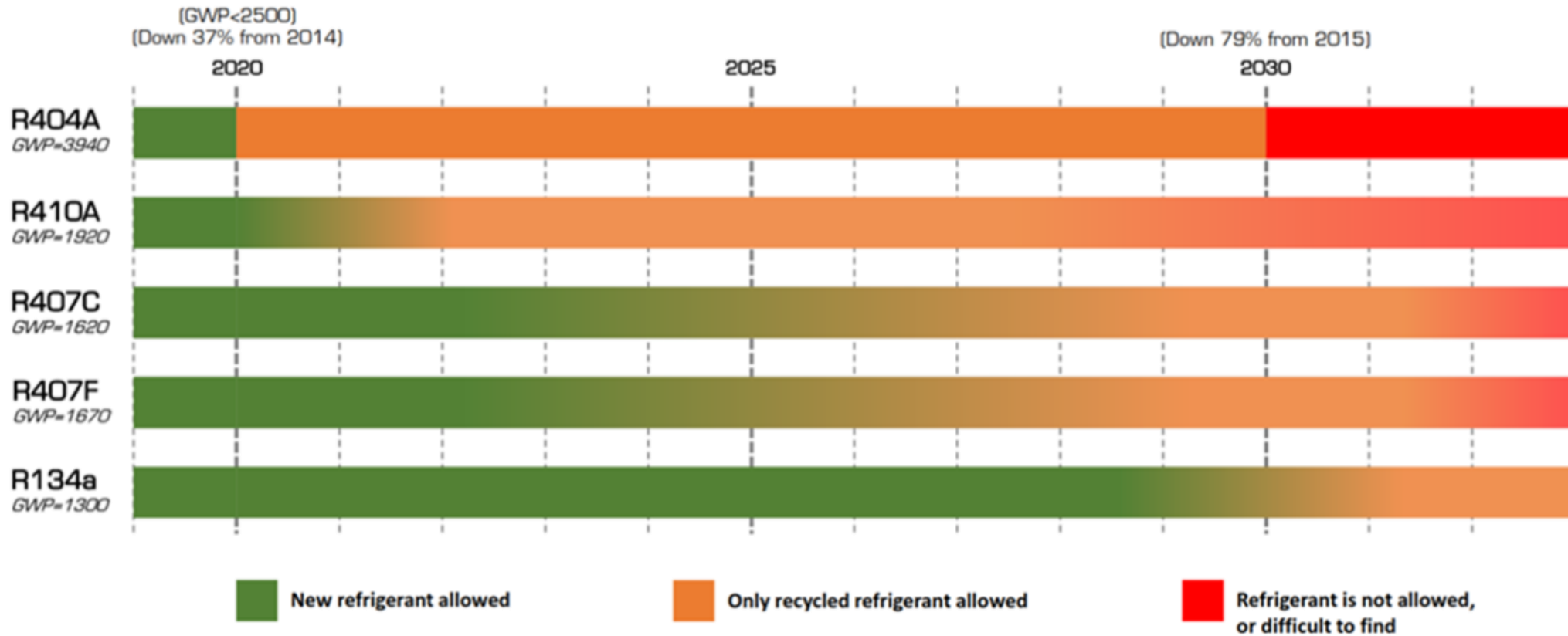
F-Gas regulations

Fluorinated greenhouse gases

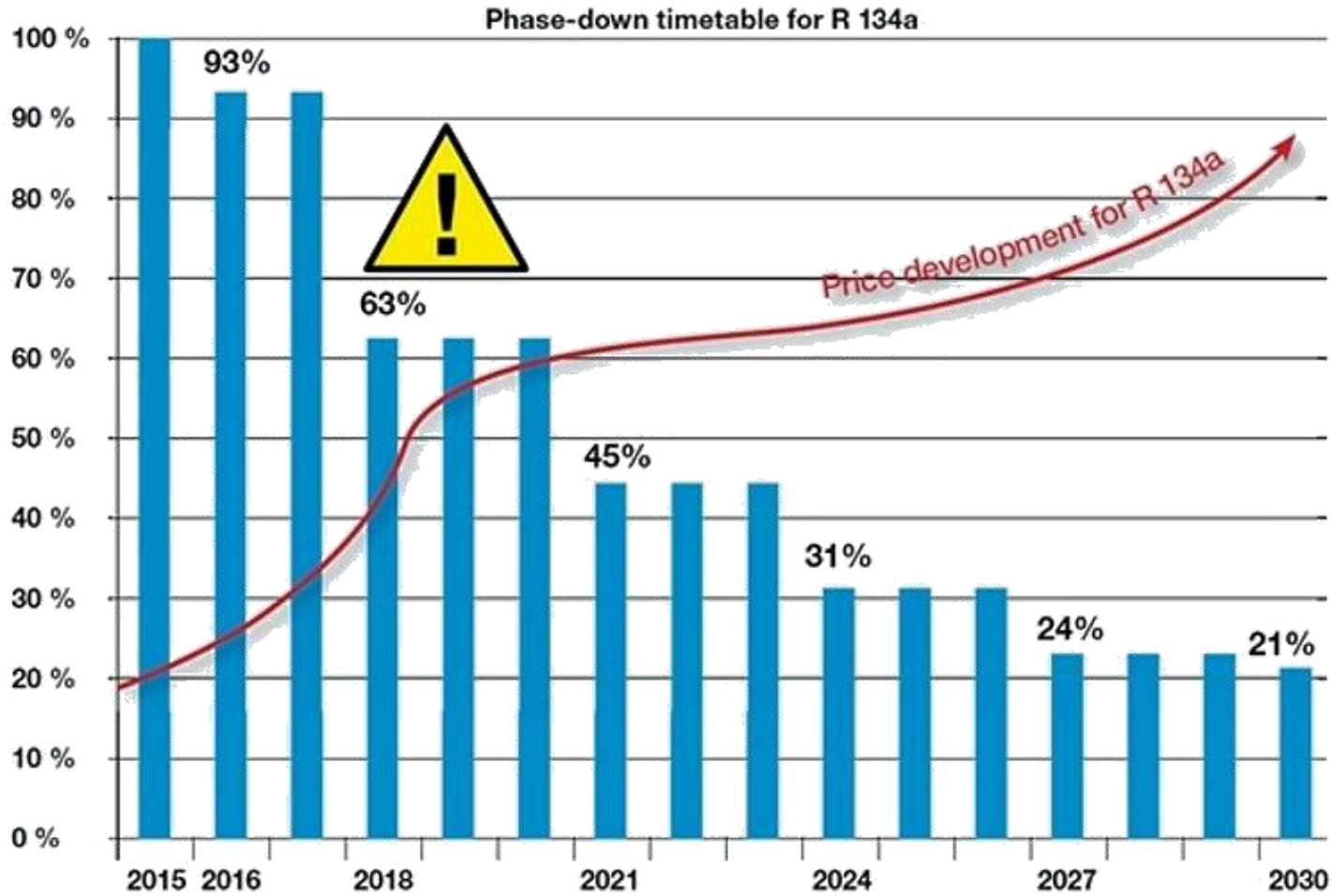
- EU regulation
- Prevent and reduce emissions of F-gasses that contribute to global warming
 - R-134a, R-410a etc.
- Total phase out by 2050
- Based on quota system
- NOT valid for marine industry ?
- What will Flag states do..?



F-Gas regulations



R134a phase down



Source: European Partnership for Energy and the Environment

History and regulations

PFAS regulations

Per- and Polyfluoroalkyl Substances

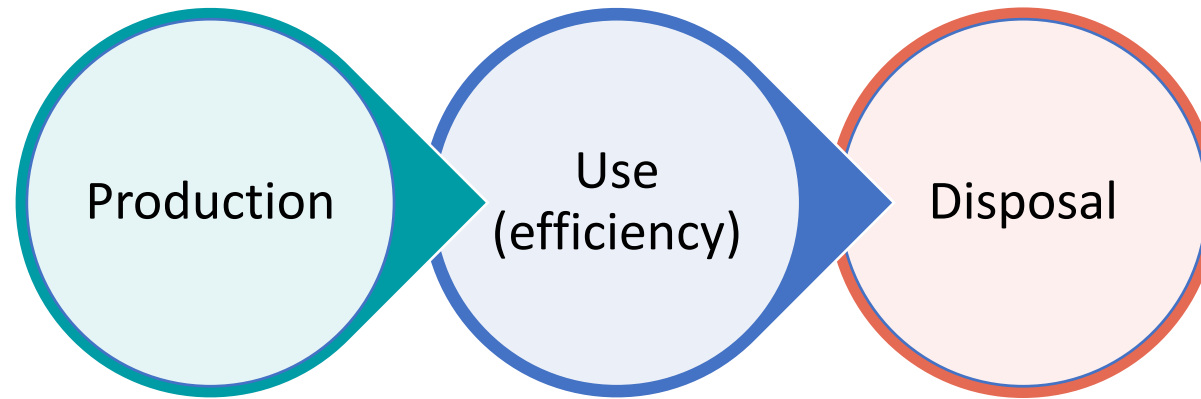
- “Forever chemicals”
- World-wide regulations
- Environmental pollutants
- Negative effects on human health
- Potential ban of these synthetic chemicals
- HFO covered
- Timeline:
Restrictions effective from 2026/2027 ?

Will also cover other well-known products like Gore-Tex and Teflon.



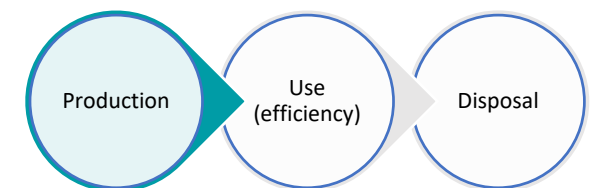
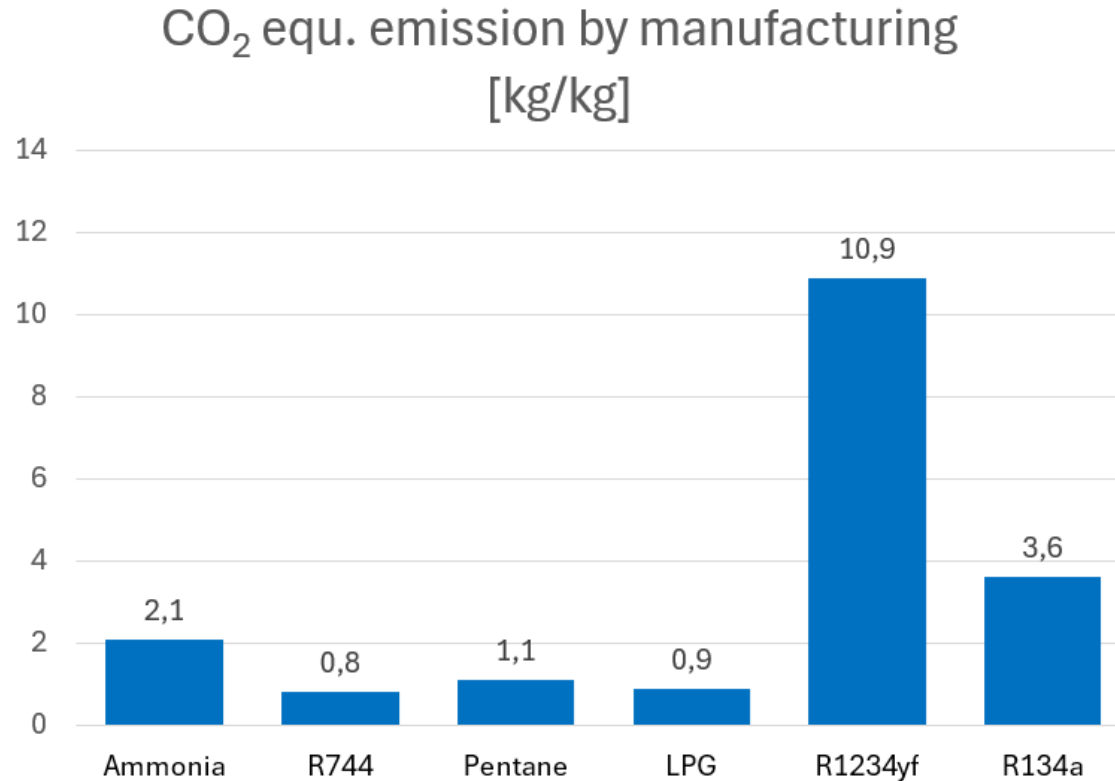
Cradle to grave

Total emission



Cradle to grave

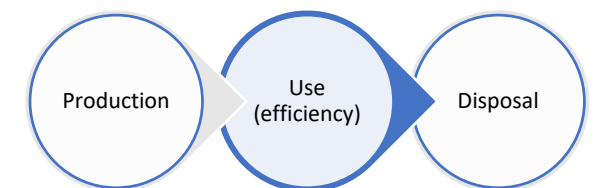
New HFOs are the most energy intensive to produce



Cradle to grave

Some of the more environmentally friendly are less efficient

- HFO (R-1234, R-513A etc.) are similar in COP as HFC (R-134a etc.)
- Ammonia are similar to HFO and HFC in COP
- CO₂ are more dependent on cooling water temperature
 - But is this true?



Cradle to grave

ODP – Ozone Depletion Potential

Not an issue anymore (Montreal)

GWP – Global Warming Potential

(Kigali amendment and F-gas regulations)

CO ₂	1
R-134a	1430
R-513a	631
R-1234ze	7
Ammonia	0

TFA - Trifluoroacetic acid

“Forever chemical” (PFAS)



Cradle to grave

TFA

Trifluoroacetic acid: a “forever chemical”

Decomposition:

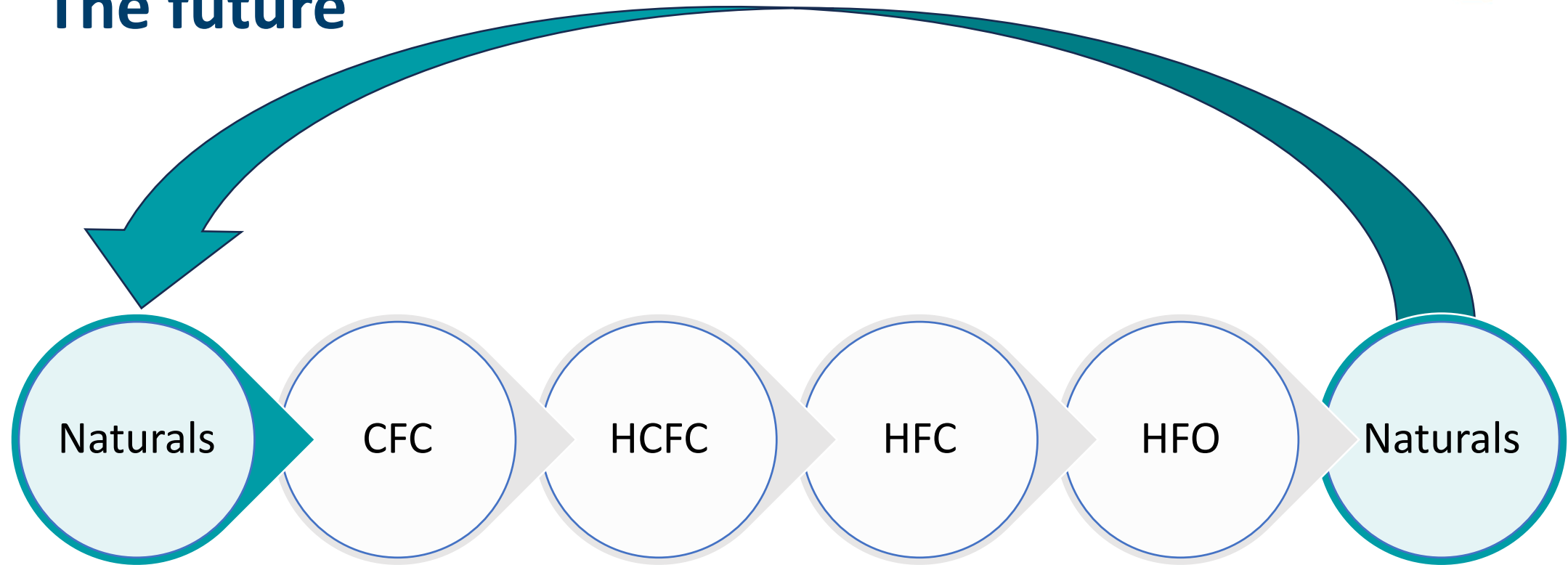
- HFOs decomposes to TFA in various degree
- HFOs can become the main source of TFA
- 7-20% of HFC-134a emissions degrades into TFA.
- HFO-1234yf emissions decomposes fast and completely into TFA.
- 10% of HFO-1234ze(E) emission decompose into TFA.

Risk (potential):

- Can harm human reproductive function, fertility and fetal development.
- Hormonal changes and deformities.
- Damage to the immune system.
- Damage to the liver and fat metabolism (such as obesity).





The future



Practical measures / design implementation



Class

	CO2 – R744	Ammonia – R717	Propane – R290	R1234ze (HFO - For comparison)
	<ul style="list-style-type: none"> • Group 1 refrigerant. • Located in separate machinery room. • Alarm at $C_{CO_2} > 1500$ ppm, visual and optical, ventilation activated. • Systems with less than 25kg can be placed in engine room (each unit). 	<ul style="list-style-type: none"> • Group 2 refrigerant. • Separate room, special consideration of ventilation outlets, additional catastrophe ventilation etc. • Systems with less than 25kg can be placed in engine room (each unit). 	<ul style="list-style-type: none"> • Currently not allowed withing regulations due to higher flammability. • Approval possible on a case-by-case basis: Indicated similar rules as for LPG, and location above waterline. 	<ul style="list-style-type: none"> • Group 1 refrigerant up to 3kW prime mover – approximately 10 kW cooling capacity. • Above it is considered group 2.
	<ul style="list-style-type: none"> • No need for separate machinery room for chiller. • Catastrophe ventilation 30 ACH. • Ventilation activated at $C_{CO_2} > 5000$ ppm 	<ul style="list-style-type: none"> • Similar to DNV. 	<ul style="list-style-type: none"> • Currently allowed within regulations. Requirements are not 100% clear. According to LR they had already projects with Propane chiller. 	<ul style="list-style-type: none"> • Not specifically stated in rules.

Practical measures / design implementation

Recommendations

General

- Low filling, less piping, better welding
- No DX plants
- Separate room
- Ventilation

Chillers and heat pumps

- CO₂
- Ammonia
- Low GWP synthetic refrigerants

Provision plants

- CO₂
- Brine (indirect as a chilled water system)



References

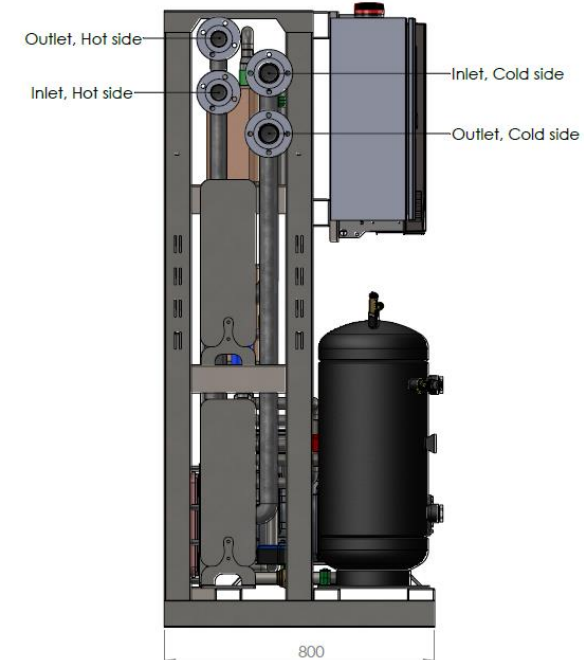
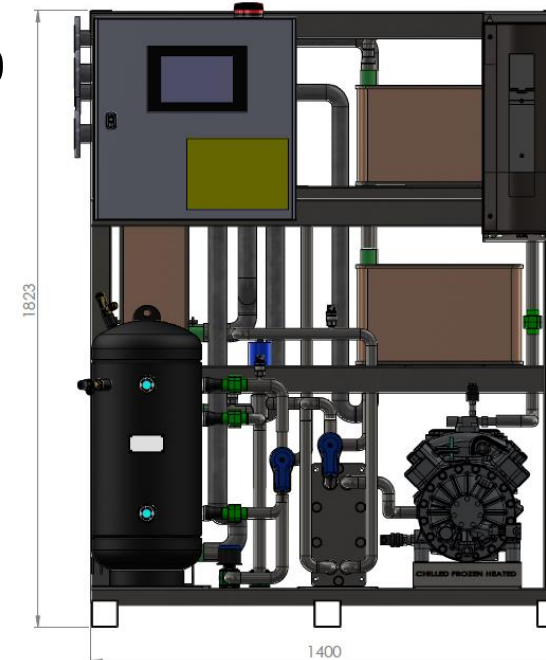


NVC 4055 - Eidsvaag Forage Carrier

CO₂ combined chillers and heat pumps

	Chiller mode	Heat pump mode
Capacity (kW)	120	130
CW temp (°C)	10/16	0/6
HW temp (°C)	50/25	75/30
COP	3,31	2,20
Size B x D x H (mm)	1400 x 800 x 1823	

2 pc/ship(2) – Deliver Q3 -26 / Q1 -27

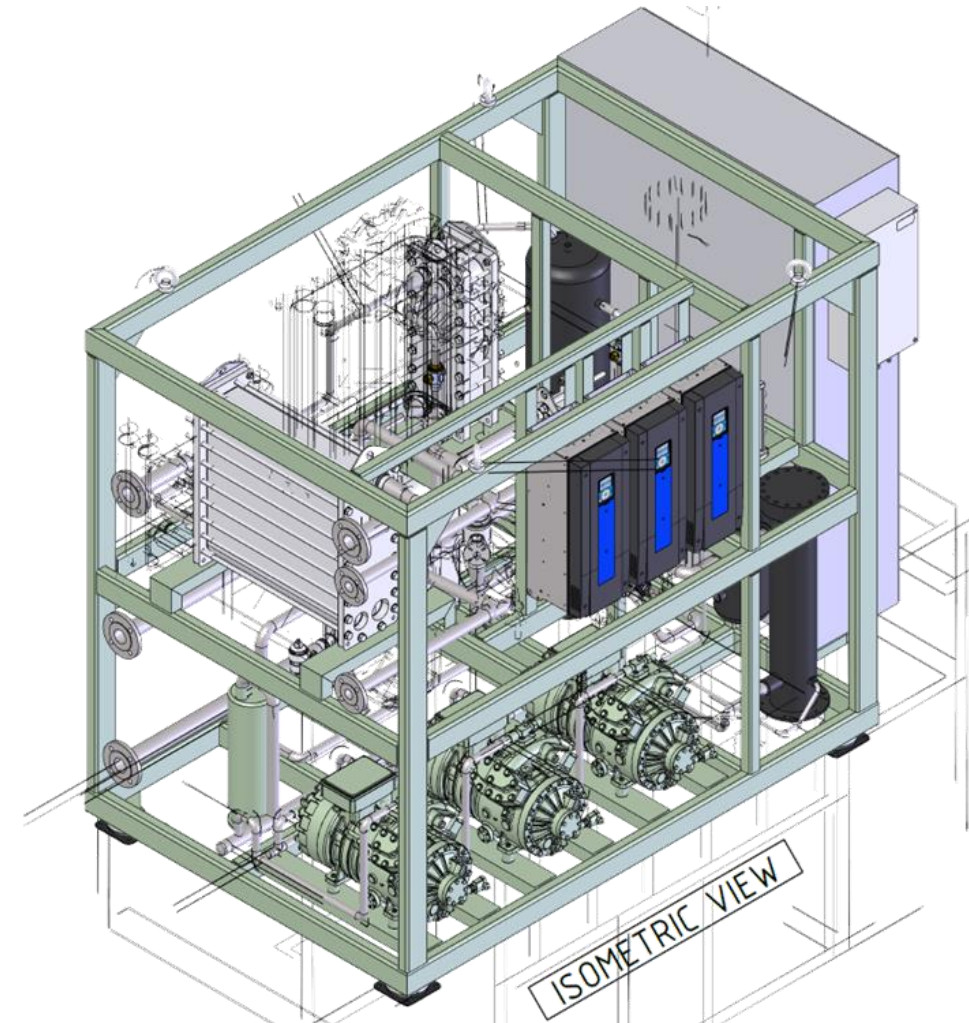


Scandlines RoRo Ferry

CO₂ combined chillers and heat pumps

	Chiller mode	Heat pump mode
Capacity (kW)	270	133
CW temp (°C)	10/16	-2/-0,5
HW temp (°C)	42/23	45/30
COP	3,30	3,08
Size B x D x H (mm)	2600 x 1500 x 1950	

2 pc/ship(1) – Delivery ship 2026



Scandlines RoRo Ferry

Provision plant (brine)

Serving 3 rooms 4°C and 12°C

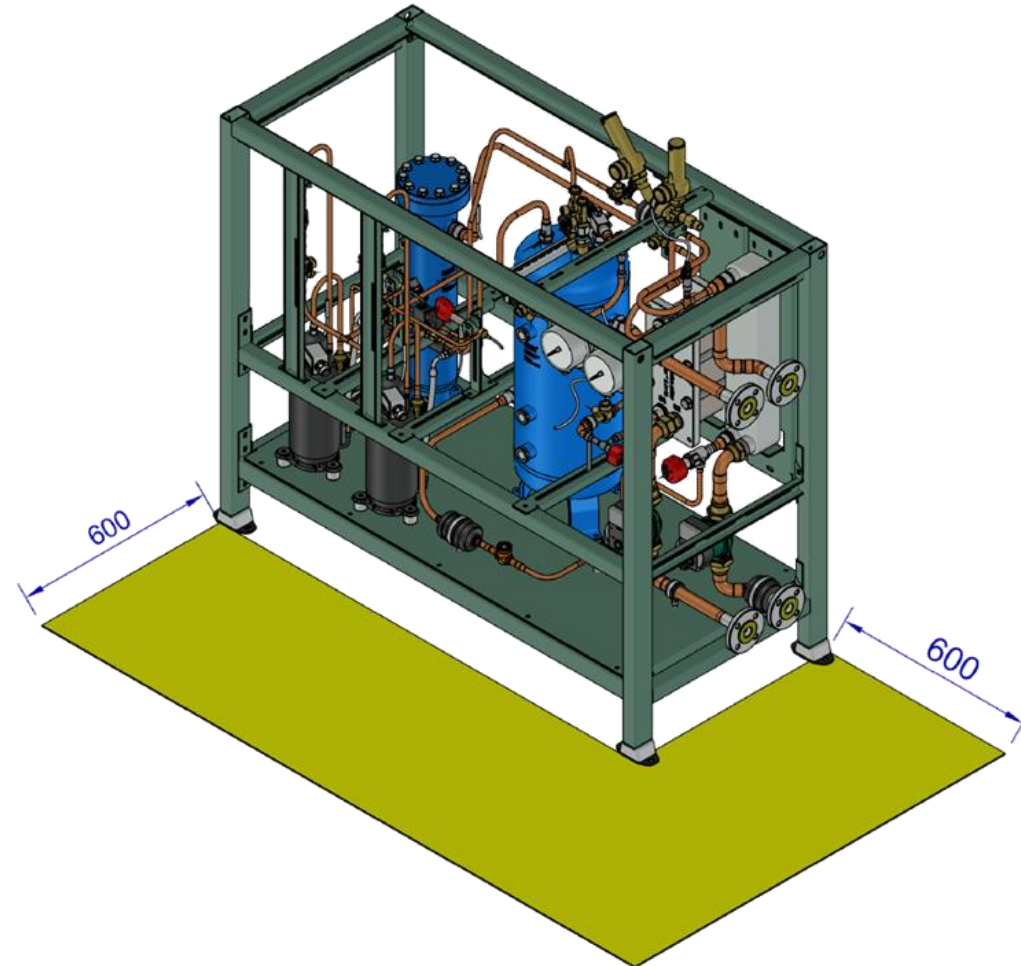
Compressors 2 pc

Heat exchangers 2 pc

Distribution Brine

Size B x D x H (mm) 1480 x 650 x 1438

1 pc/ship(1) – Delivery ship 2026



References

Ammonia

More than 30 plants for fishing vessels

- Cargo hold refrigeration plants
- Freezing plants
- RSW refrigeration plants
- Provision plants
- HVAC chillers
- Slury-ice plants



