

# Consultation Forum:

Preliminary results:

Availability of alternatives to HFCs in commercial  
refrigeration in the EU



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with DG CLIMA

# Background

- Assessment of prohibition on multipack centralised refrigeration for commercial use
- Input for EC report regarding Article 21(3)
- Mission: assess availability of cost-effective, technically feasible, energy-efficient and reliable alternatives



# Regulation (EU) No 517/2014

## Annex III (13) prohibition:

*“Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 150 or more, except in the primary refrigerant circuit of cascade systems where fluorinated greenhouse gases with a GWP of less than 1500 may be used.”*

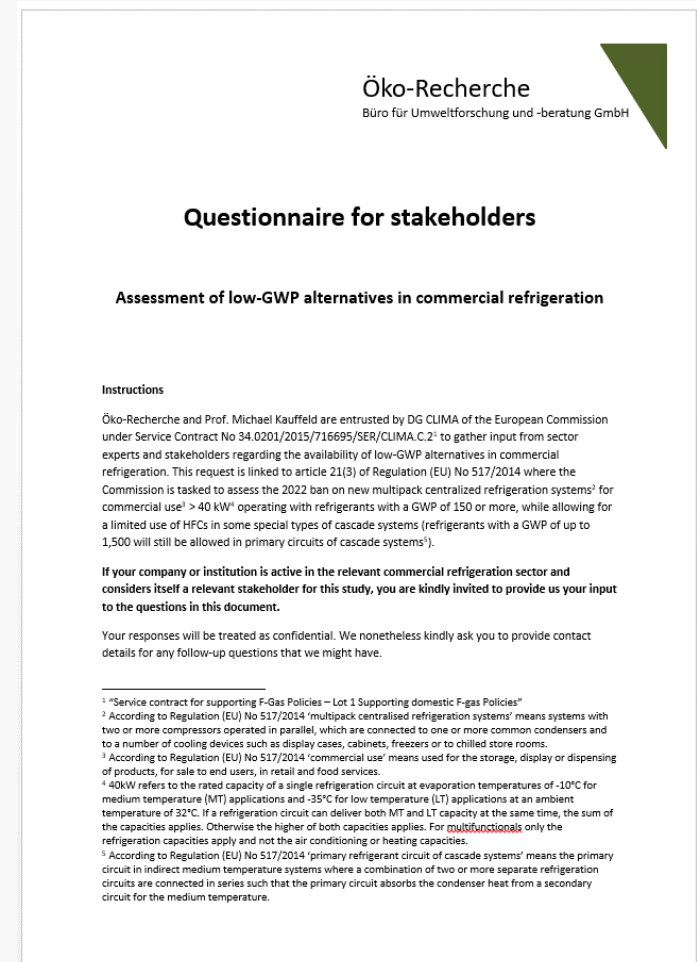
# Approach

- Technology assessment led by Prof. Kauffeld
- Analysis of affected systems and available technological options
- Questionnaire to gather stakeholder input
- Dissemination directly and via industry associations, events, meetings and workshops
- Close dialogue with industry experts



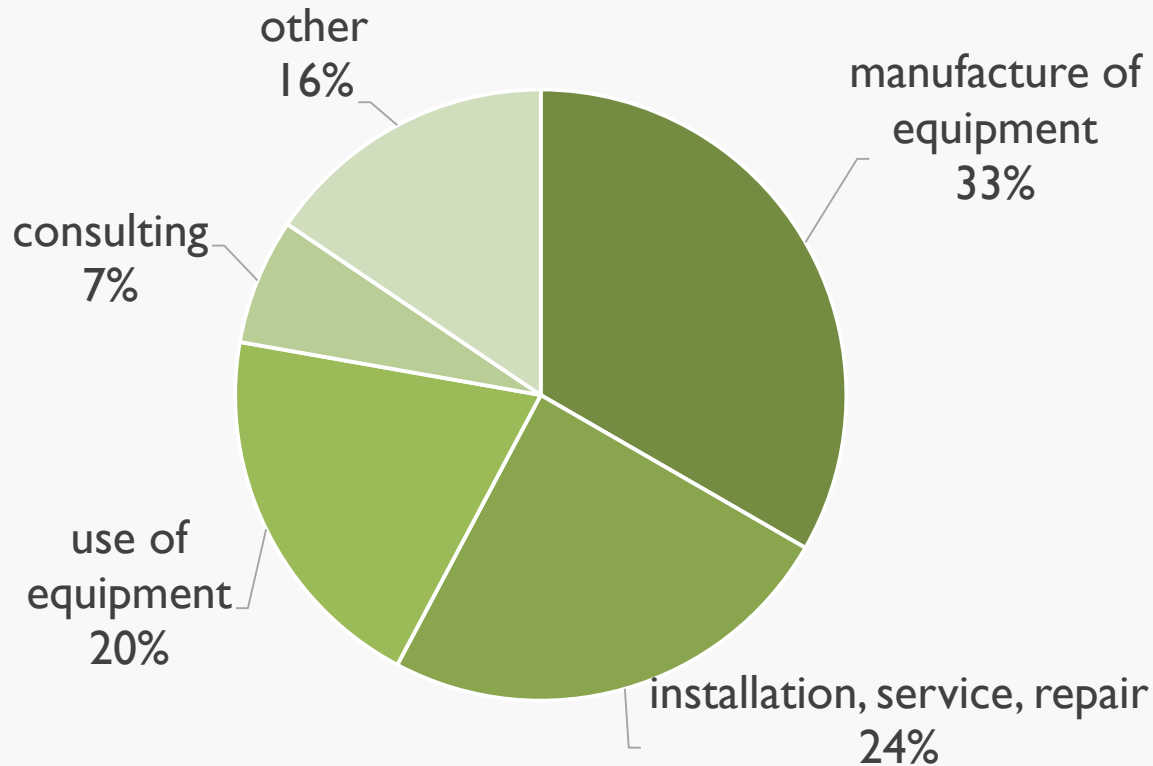
# Outreach and dissemination

- Total of 17 questions on:
  - F-gas Regulation
  - State of technology
  - Alternative options
  - Feasibility and reliability
  - Energy efficiency
  - Cost effectiveness
  - Obstacles
- Outreach to >143 organisations in 19 EU countries
- Refrigerant, component and equipment manufacturers, end-users, consultants, NGOs and research institutes were included

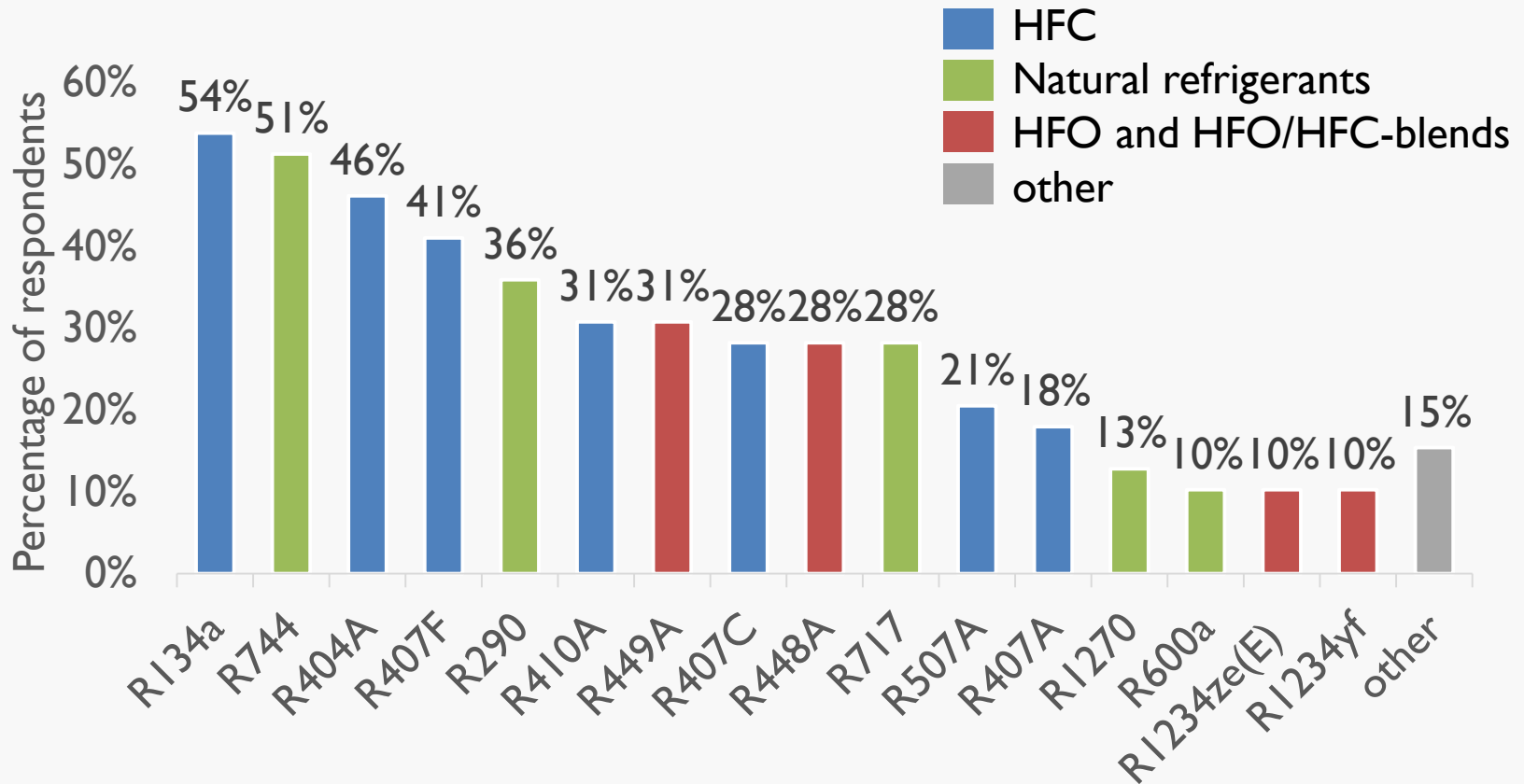


# Feedback

- 39 responses (incl. 18 from EU South)

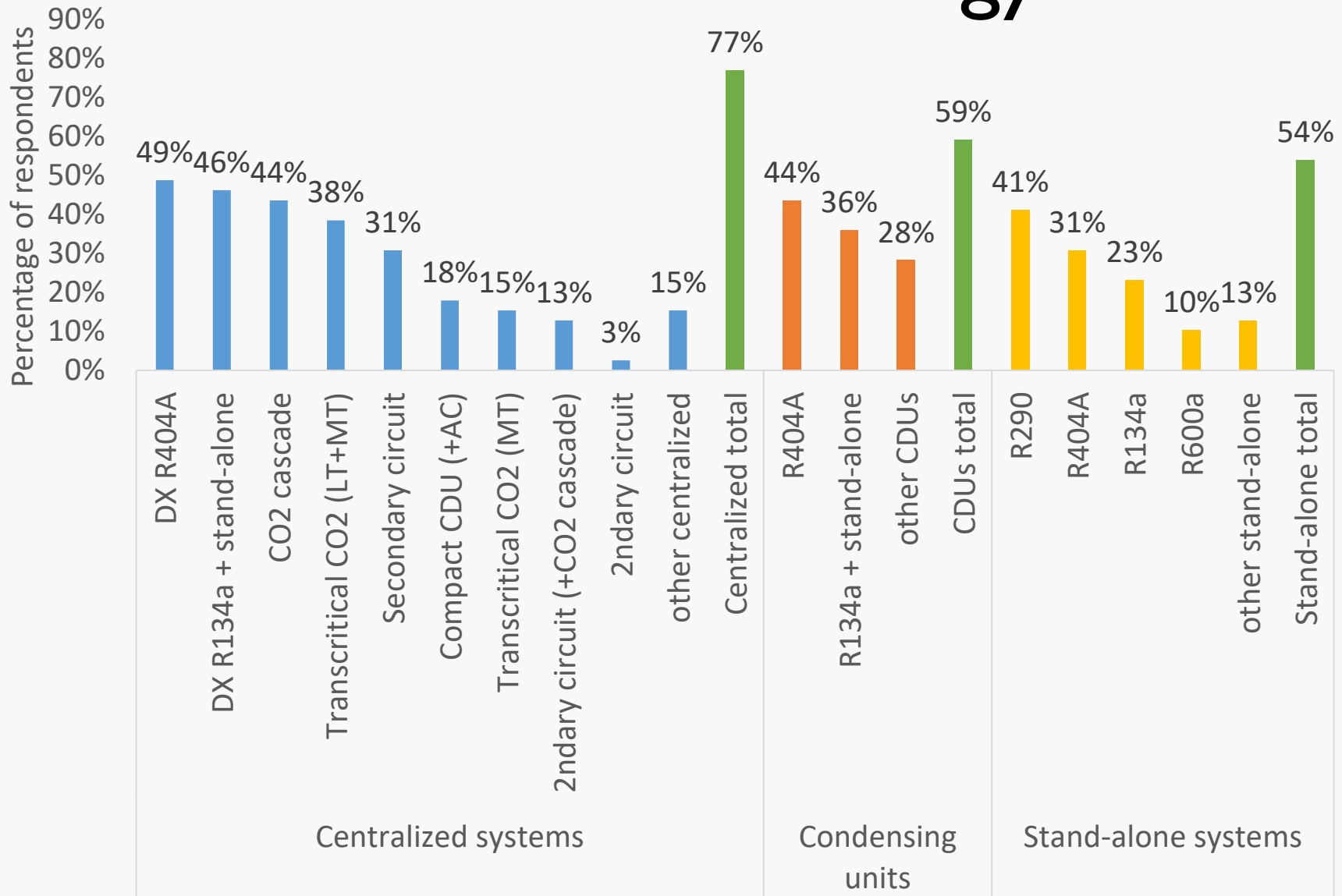


# State of technology



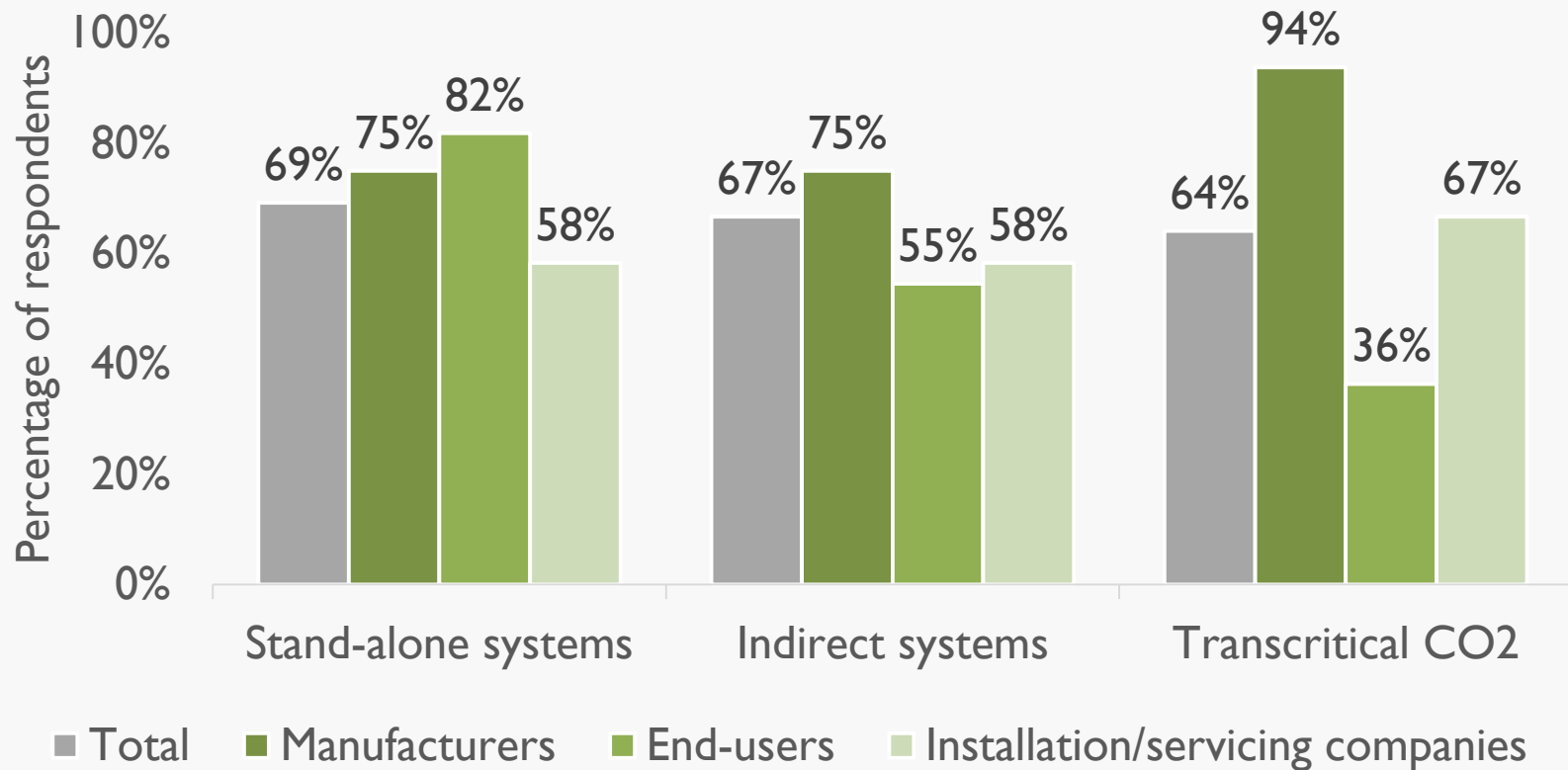
→ Natural refrigerants no longer a niche technology but HFCs still dominate market

# State of technology





# Technical options for meeting the prohibition

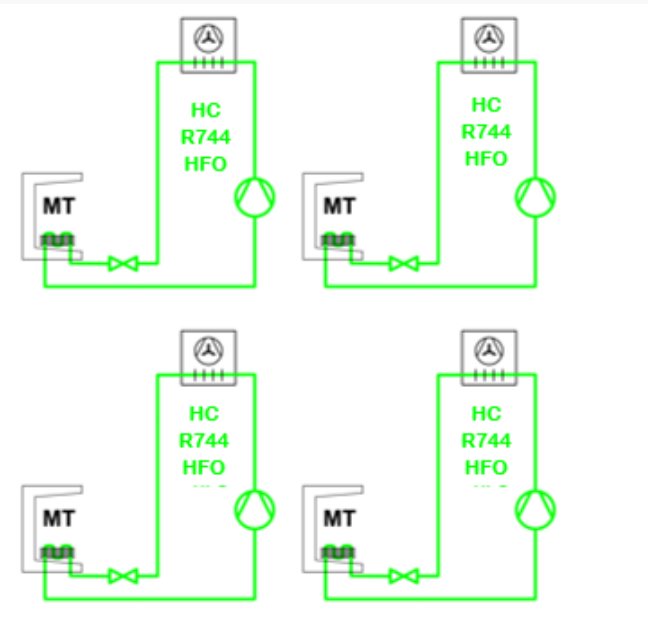


# Available technical options for meeting the prohibition: Stand-alone systems

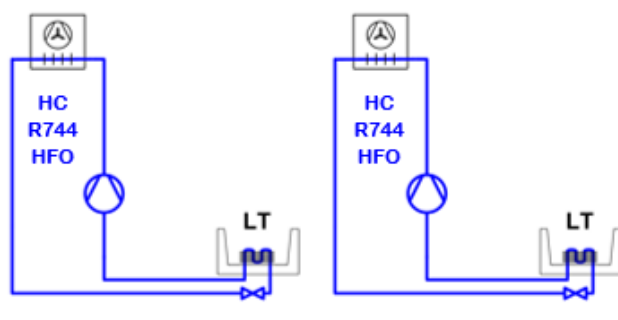
## Sample system schematic

## System description

## Requirement for system to fulfill 2022 prohibition



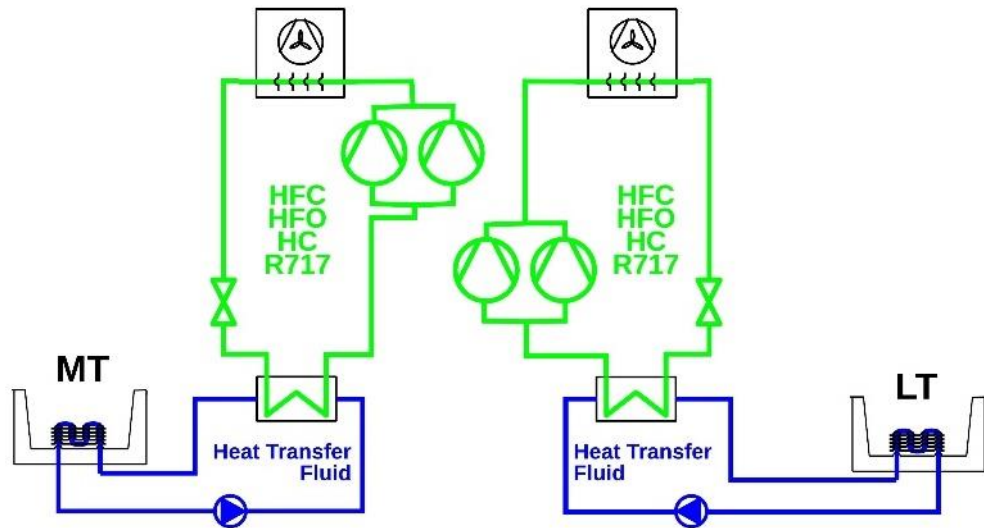
## Stand-alone systems (hermetically sealed)



(According to Regulation (EU) No 517/2014 Annex III (11) HFCs above GWP 2500 are prohibited from 1 January 2020 and HFCs above GWP 150 from 1 January 2022 on.)

# Available technical options for meeting the prohibition: Indirect systems (i)

## Sample system schematic



## System description

**Indirect centralised system**

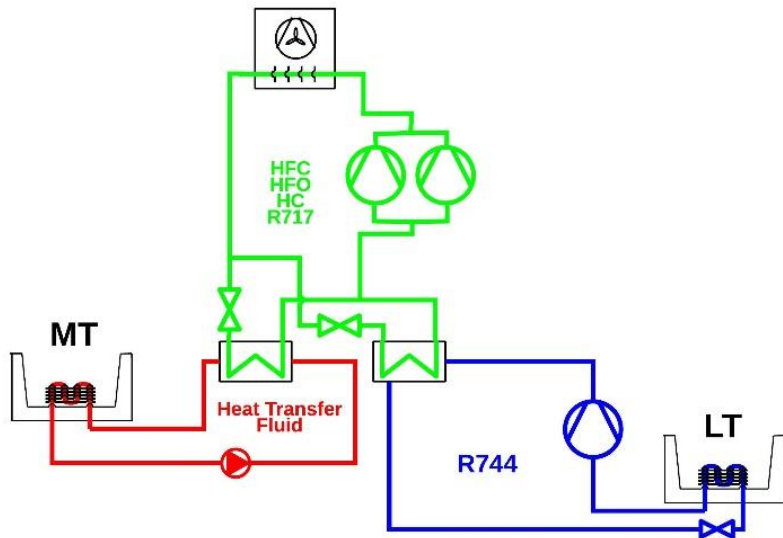
(i) Separate secondary MT/LT refrigeration circuits

## Requirement for system to fulfill 2022 prohibition

**< 150 GWP**

# Available technical options for meeting the prohibition: Indirect systems (ii)

## Sample system schematic



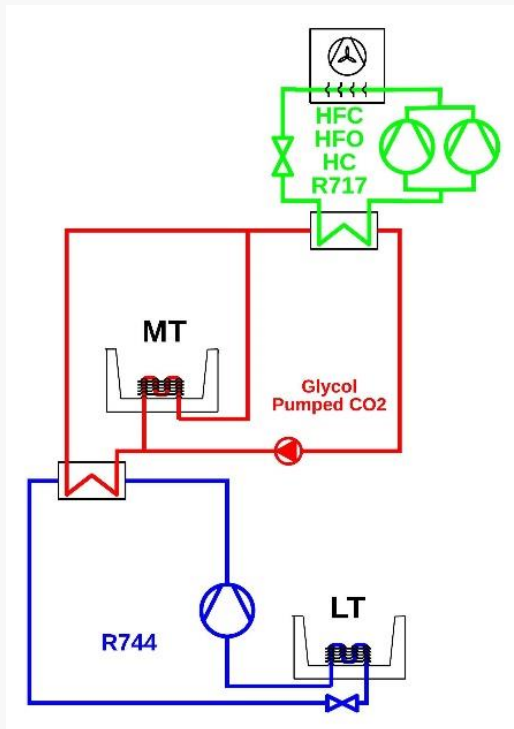
## System description Requirement for system to fulfill 2022 prohibition

**Indirect centralised system** **< 1,500 GWP in primary circuit**

(ii) Secondary MT refrigeration circuit and LT CO<sub>2</sub> cascade **< 150 GWP in other circuits**

# Available technical options for meeting the prohibition: Indirect systems (iii)

## Sample system schematic



## System description

**Indirect centralised system**

(iii) Secondary MT refrigeration circuit (e.g. pumped CO<sub>2</sub>) and LT CO<sub>2</sub> cascade

## Requirement for system to fulfill 2022 prohibition

**< 1,500 GWP in primary circuit**

and

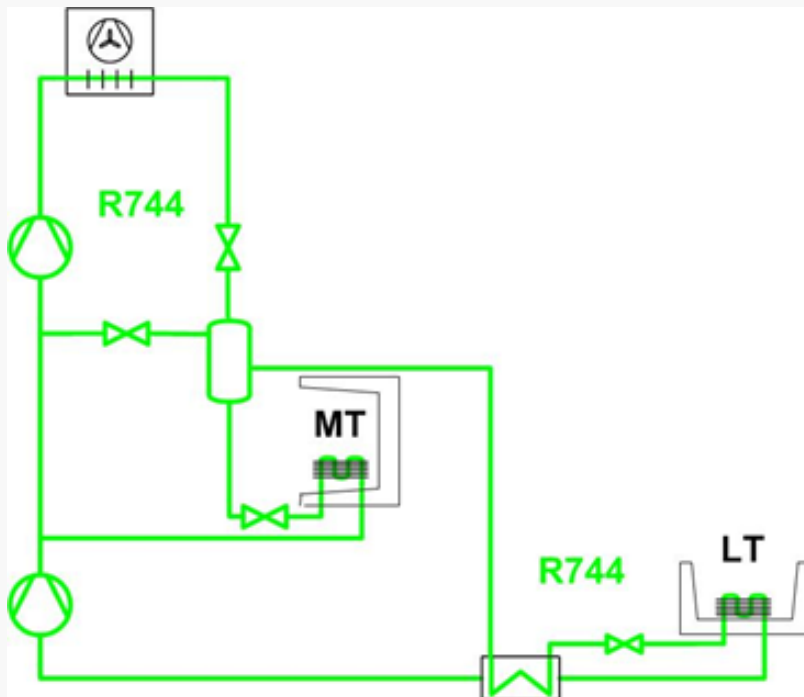
**< 150 GWP in other circuits**

# Available technical options for meeting the prohibition: Transcritical CO<sub>2</sub>

Sample system schematic

System description

Requirement for system to fulfill 2022 prohibition

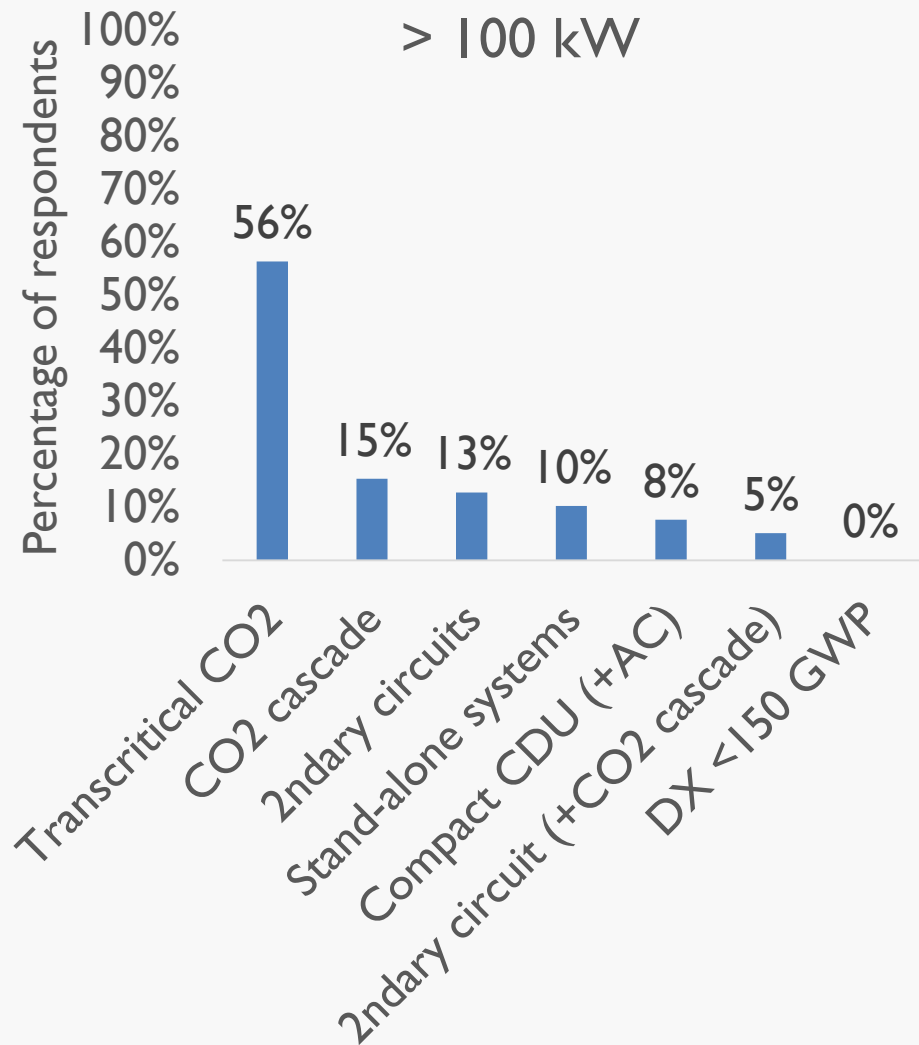
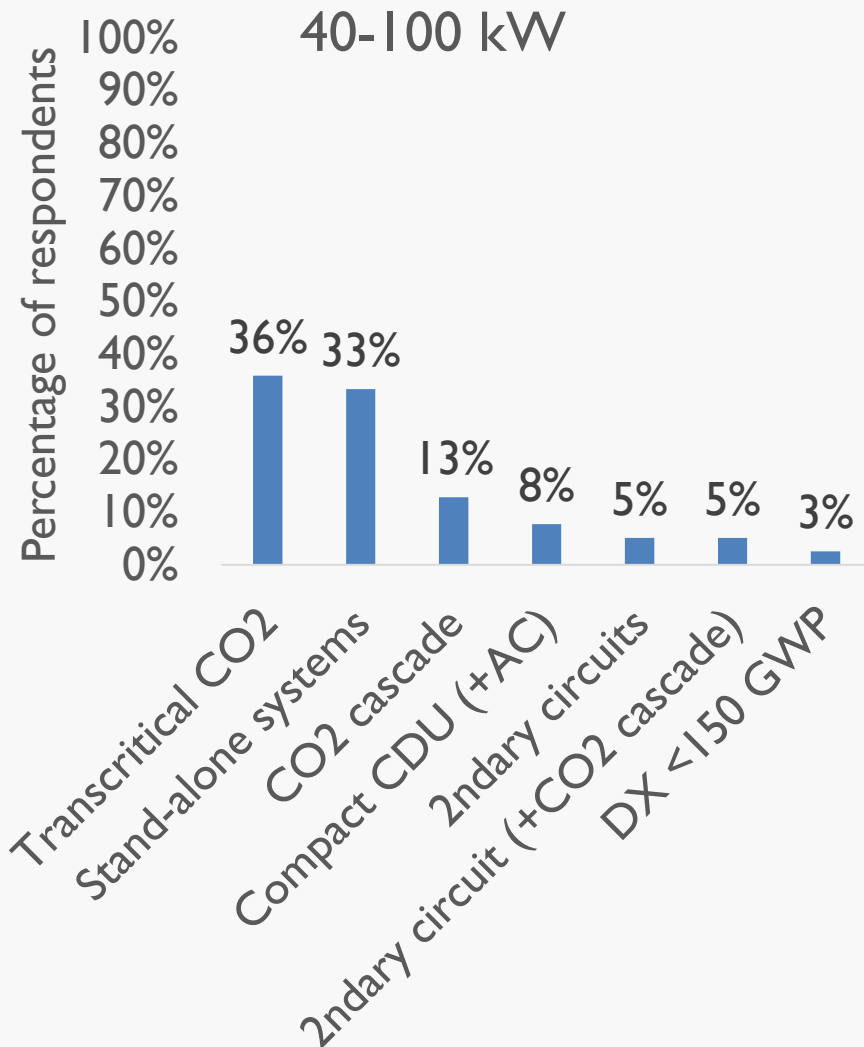


Transcritical CO<sub>2</sub>

# Feasibility and reliability of available technical options

- Stand-alone:
  - Millions of units in light commercial applications in the World
  - Semi plug-ins possible
  - Charge size limitations for flammables
- Indirect centralised systems
  - Very common in industrial applications
  - Used in supermarkets in SE, NO, LU, CH since 1990s
  - Recently R290 chillers in DE, UK, BE and CH
  - NH<sub>3</sub>/CO<sub>2</sub> cascades possible
- Transcritical CO<sub>2</sub>
  - Standard technology in many parts of EU
  - Efficiency improvements enabled installations in ES, IT and PT

# Cost effectiveness (i)



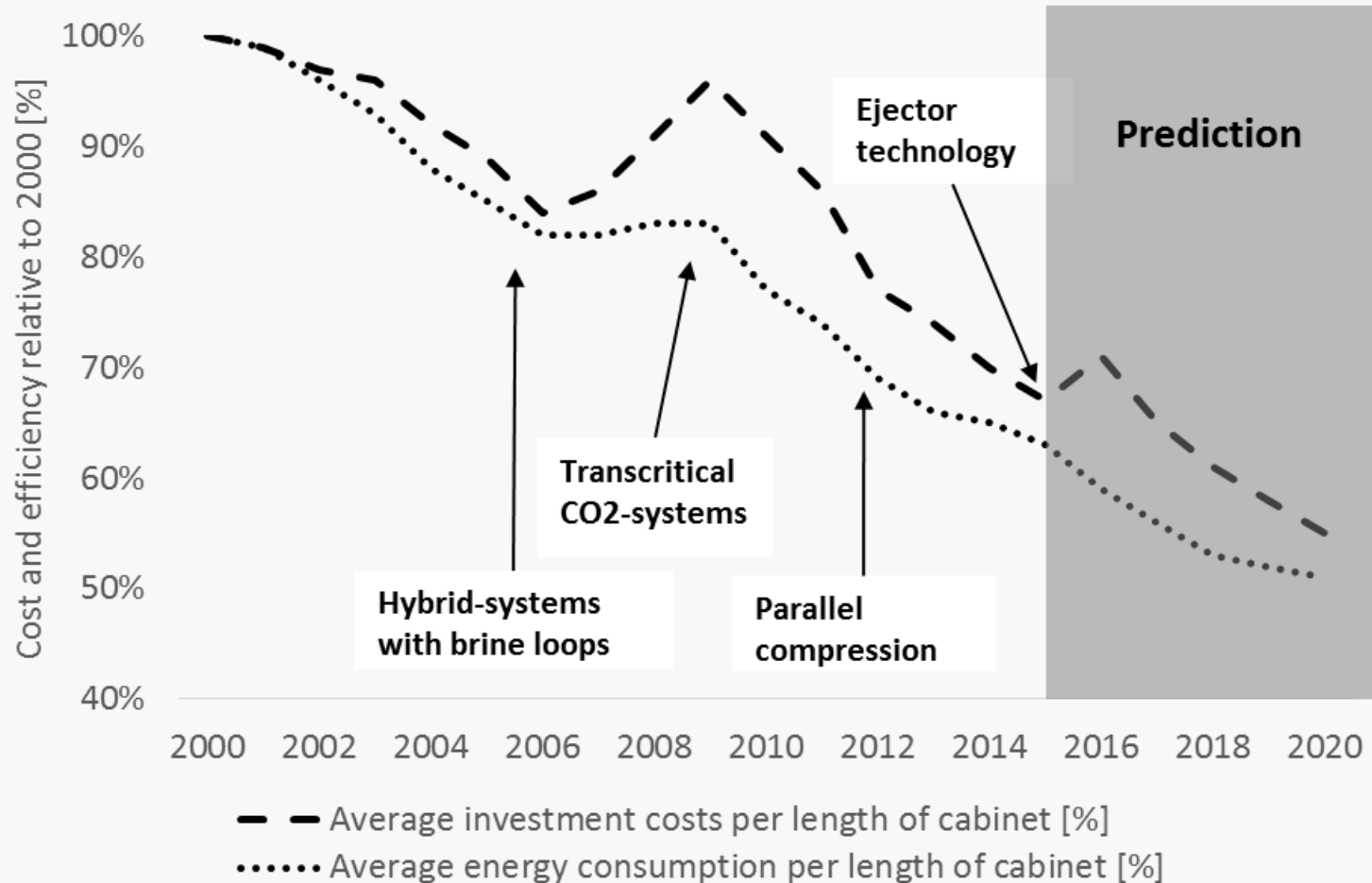


# Cost effectiveness (ii)

- Stand-alone already cost-competitive especially in small and medium stores
- CO<sub>2</sub> cascades with NH<sub>3</sub>, propylene, propane or HFOs and pumped CO<sub>2</sub> cost-competitive in large stores and hypermarkets
- Transcritical CO<sub>2</sub> already cost-competitive even in large stores

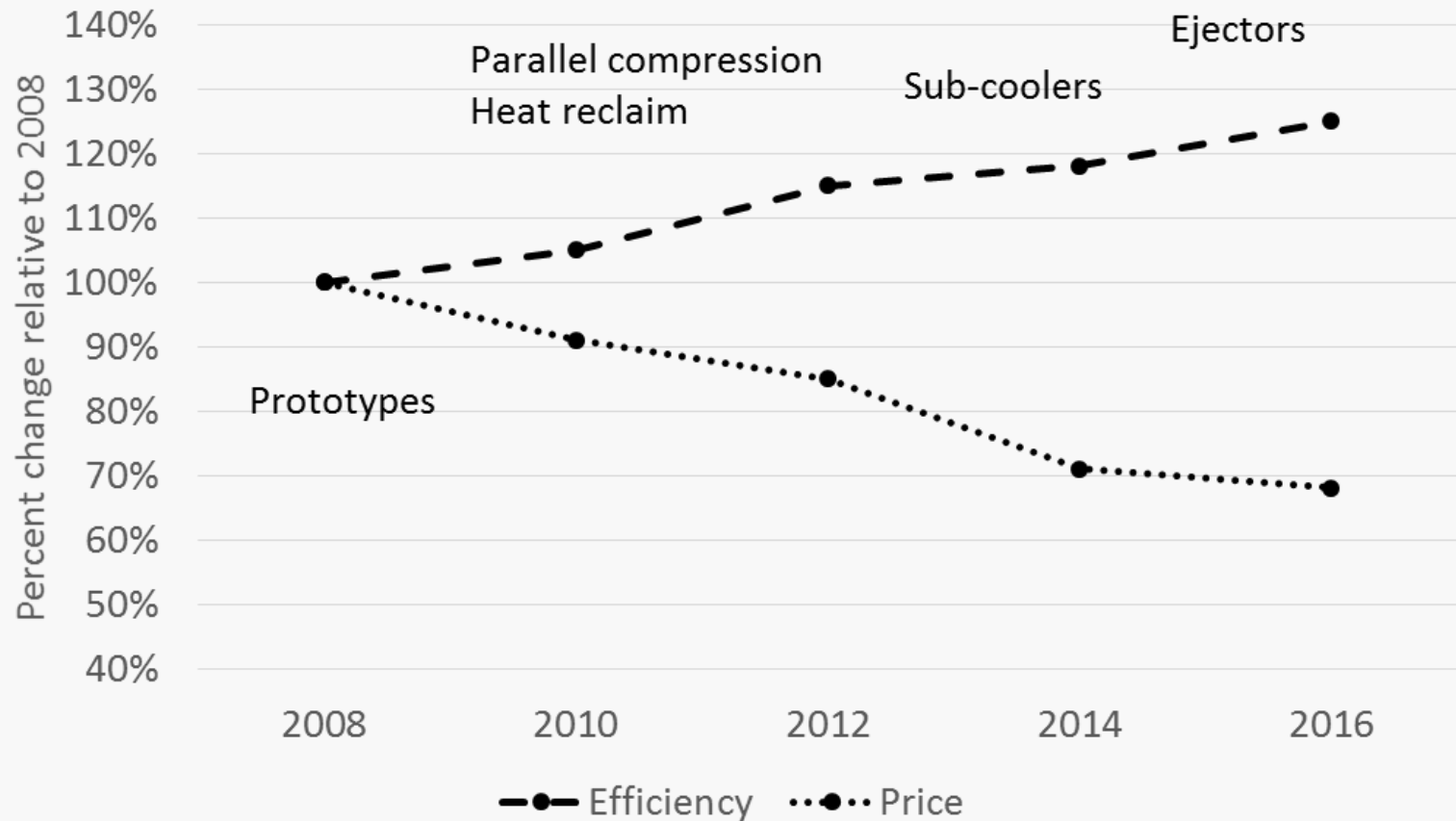


# Cost effectiveness (iii)



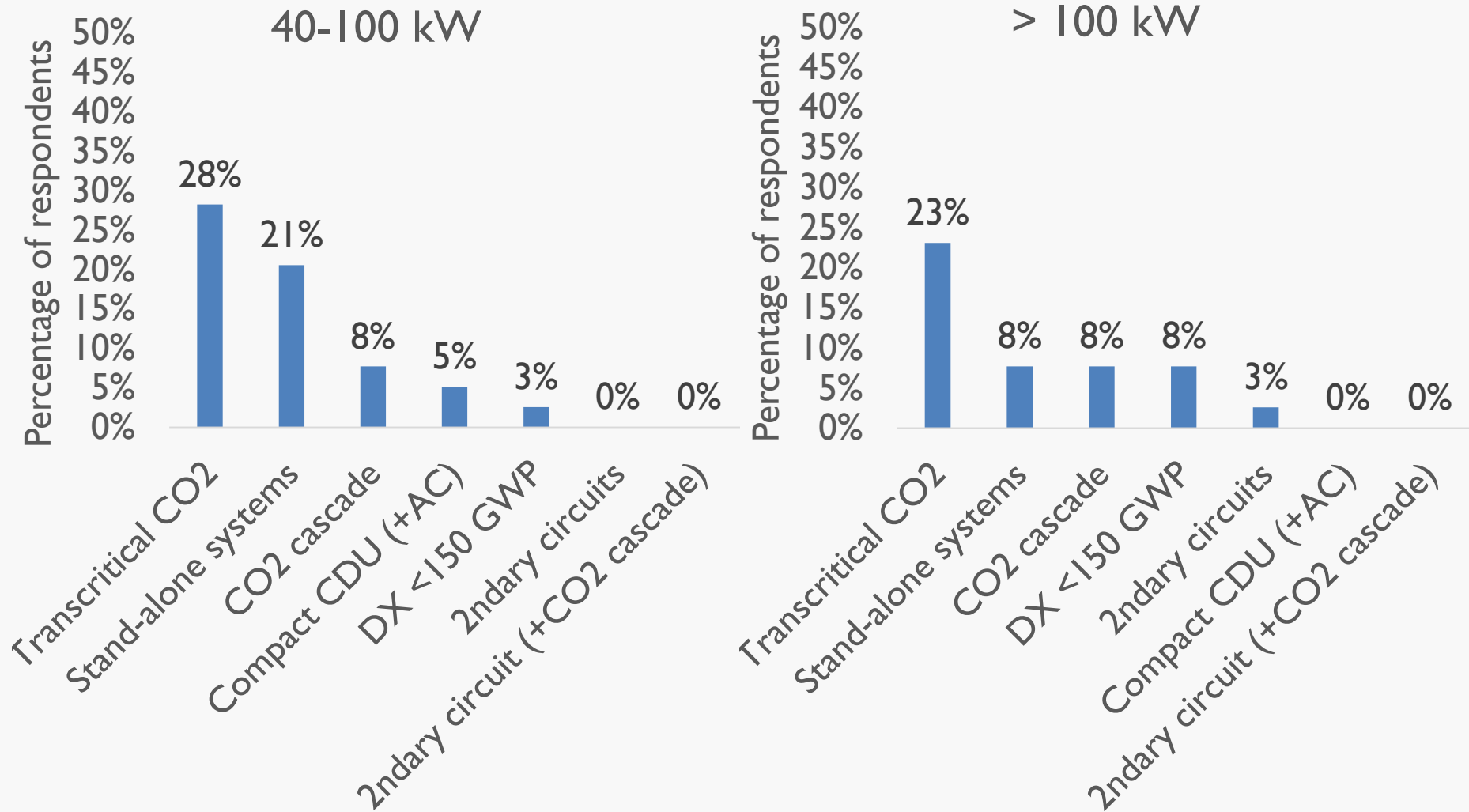
Source: Frigo-consulting AG

# Cost effectiveness (iv)



Source: Advansor

# Energy efficiency (i)



# Energy efficiency (ii)

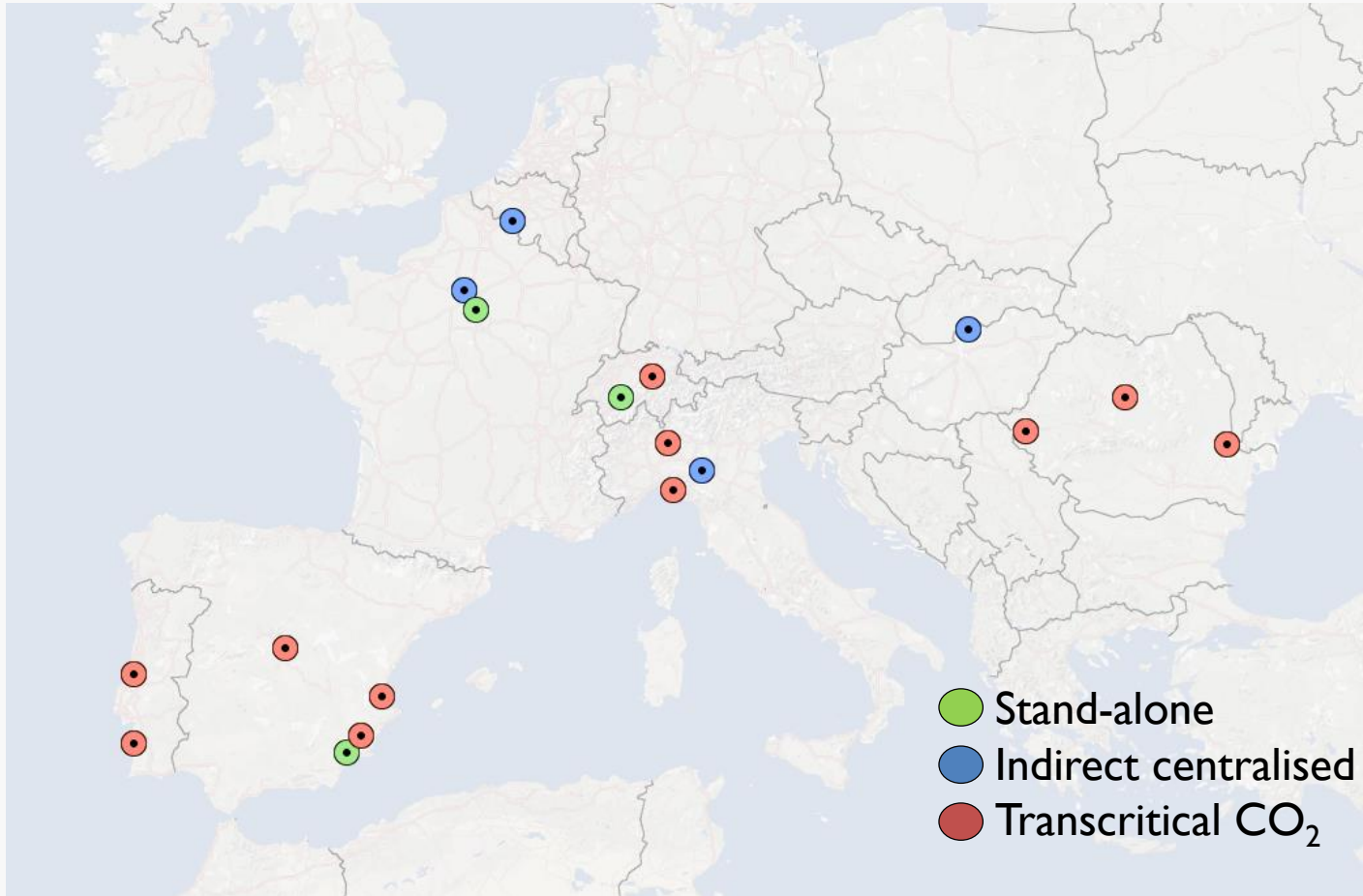
- Case studies and experts indicate:
  - Transcritical CO<sub>2</sub> offers 7-30% energy savings
  - Semi plug-ins offer around 20% savings
- Heat recovery can further increase energy savings
- Some respondents indicated HFC systems as most energy efficient



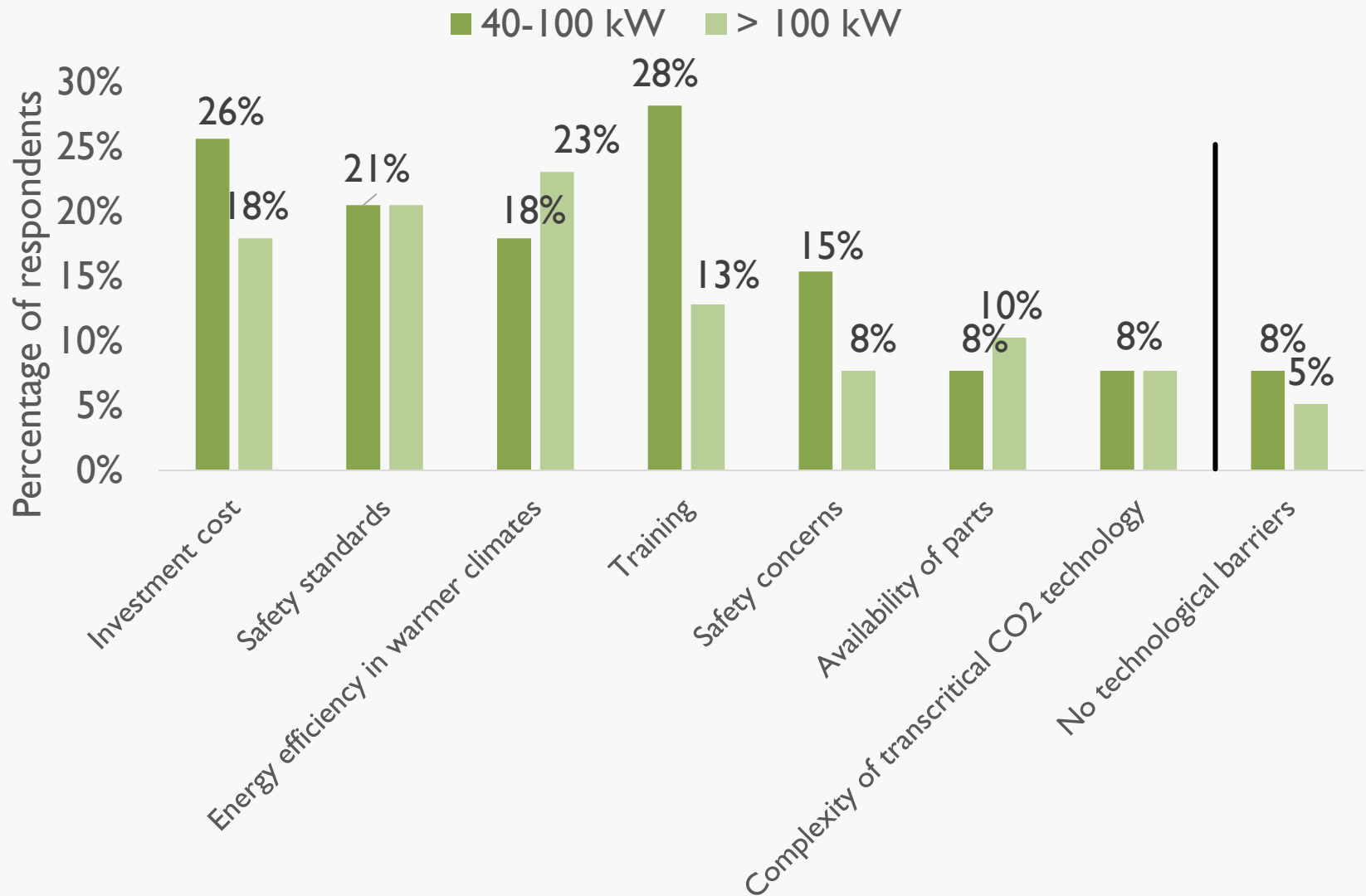
# Southern Europe

- Assessment also focused on Southern Europe
- R134a/CO<sub>2</sub> currently most used alternative
  - No longer available from 2022 on!
- **Transcritical CO<sub>2</sub>** can be efficient and already operates in ES, PT and IT
- **Stand-alone systems** (CO<sub>2</sub> and HCs) also already operate efficiently in warm and hot regions globally
- **Indirect centralised systems:**
  - Experience from South Africa and US suggest NH<sub>3</sub>/CO<sub>2</sub> cascades are efficient in warm climates
  - Likewise CO<sub>2</sub> cascade with glycol loop and R134a in primary operates efficiently in Brazil

# Detailed case studies







# Obstacles named by survey participants





# Conclusions (i)

- Successful outreach to many stakeholders (conferences, surveys, meetings with associations)
- A clear definition of systems subject to the prohibition is available
- Three system design options available today which do not fall under the prohibition

	40-100kW	>100kW
Transcritical CO <sub>2</sub>		
Stand-alone systems		
Indirect centralised systems		

# Conclusions (ii)

- Take away messages:
  - Current and fast-paced development of alternative technologies
  - Multiple technically feasible, energy-efficient and reliable alternatives available for all store formats
  - Cost effectiveness reached or will be reached by 2022



# Thank you for your attention!

## Questions...???

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[oekorecherche.de](http://oekorecherche.de)

## Links:

Resources for this project:

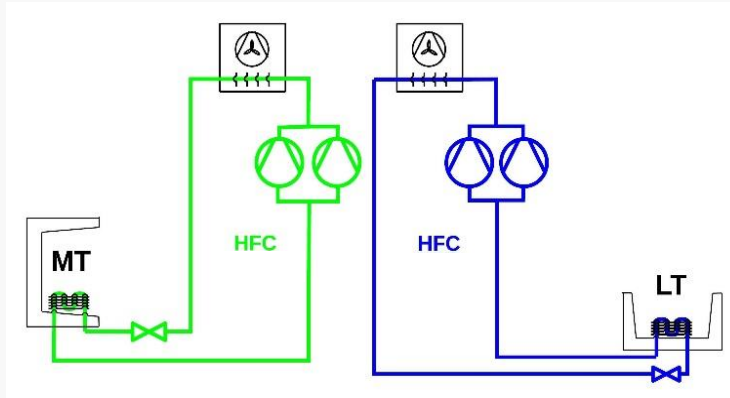
<http://oekorecherche.de/de/projekte-referenzen/unterstuetzung-der-eu-f-gas-politik>

Information regarding EU F-gas policy:

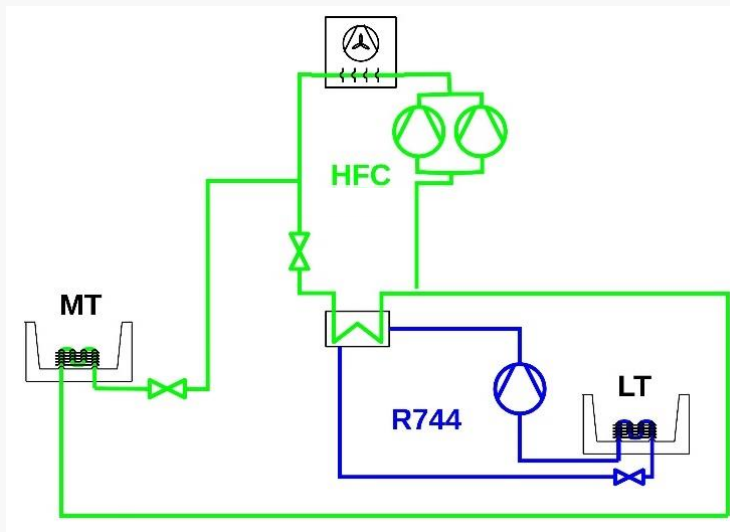
[http://ec.europa.eu/clima/policies/f-gas/index\\_en.htm](http://ec.europa.eu/clima/policies/f-gas/index_en.htm)



# Supermarkets – prohibited after 2022 ban

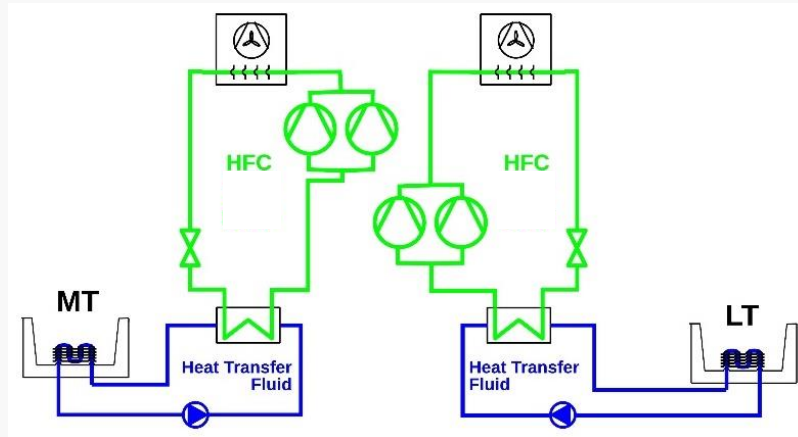


DX-systems

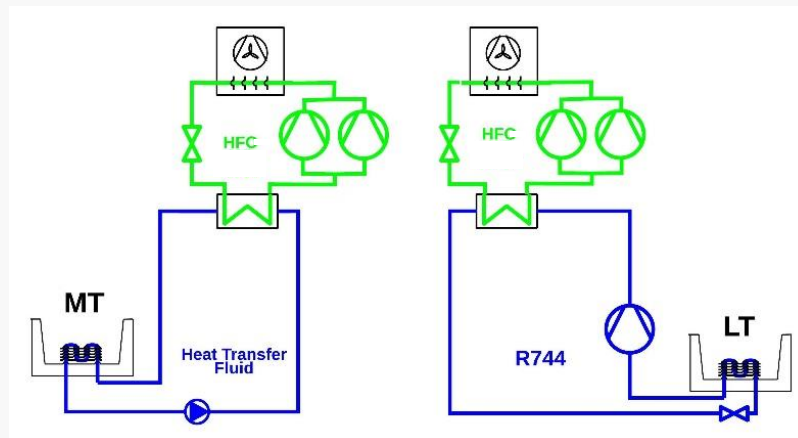


Cascade CO<sub>2</sub>

# Supermarkets – prohibited after 2022 ban



Secondary MT/LT  
refrigeration circuit



Secondary MT  
refrigeration circuit  
and LT CO<sub>2</sub> cascade