



Controlling Transcritical CO₂ Refrigeration for Sustainable System Design

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Deep industry knowledge

80-year history of engineering high efficiency solutions and environmental responsibility

Global expertise

Global expertise in refrigeration applications and refrigerants – including natural refrigerants

Broad application experience

- 10 years of experience with CO₂
- Transcritical and subcritical applications
 - More than 4,000 CO₂ installations with Danfoss solutions worldwide

#2

CO₂ in Supermarket Refrigeration



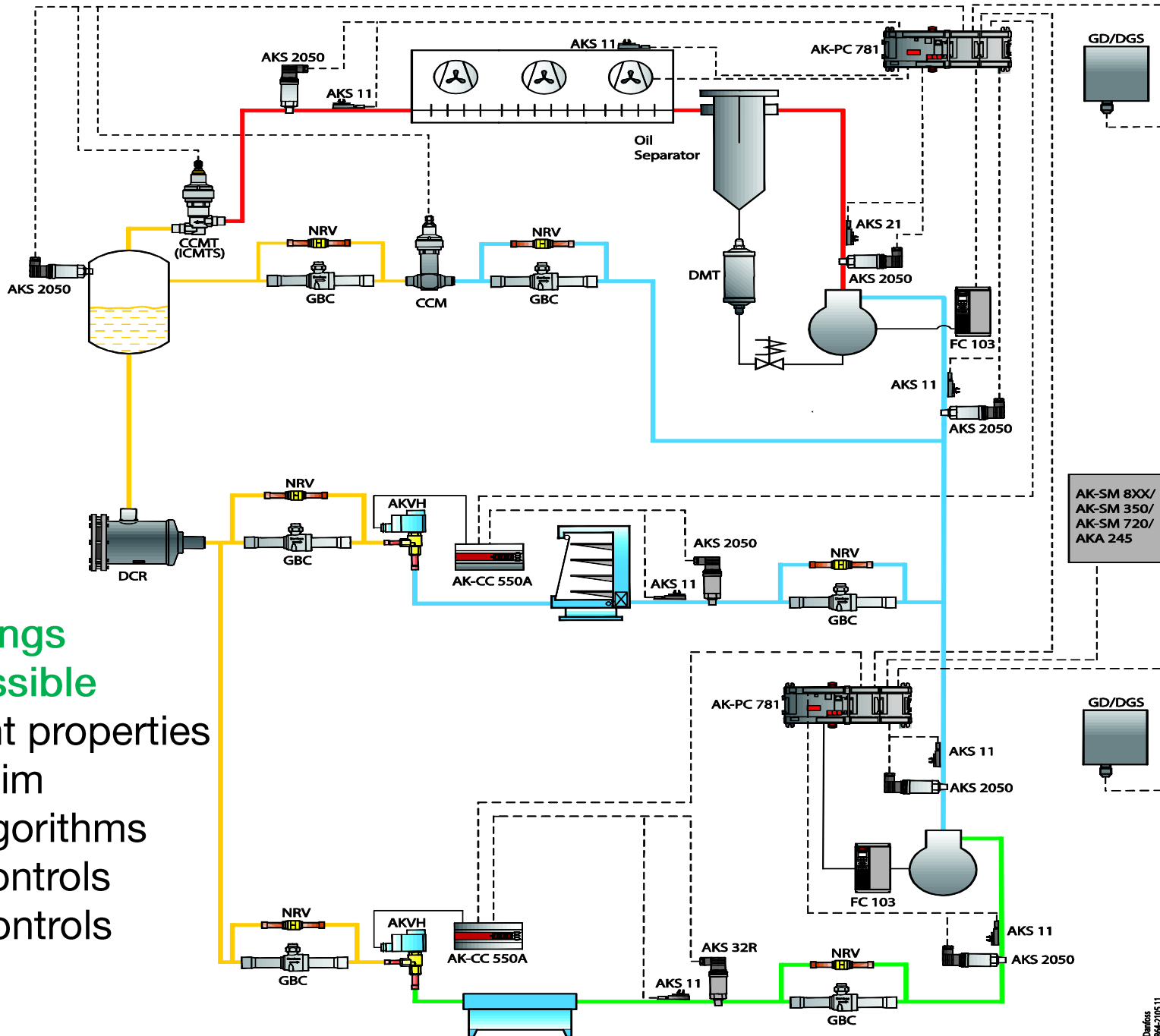
Lowest climate impact

- To lower global warming impact: reduce leaks or eliminate the source

Economically sustainable solutions

- Lowest lifetime cost
- Proven energy savings ~10-20%
- Up to 95% reduction in refrigerant cost
- Heating and cooling with one cost-effective system using heat reclaim

Proven solutions

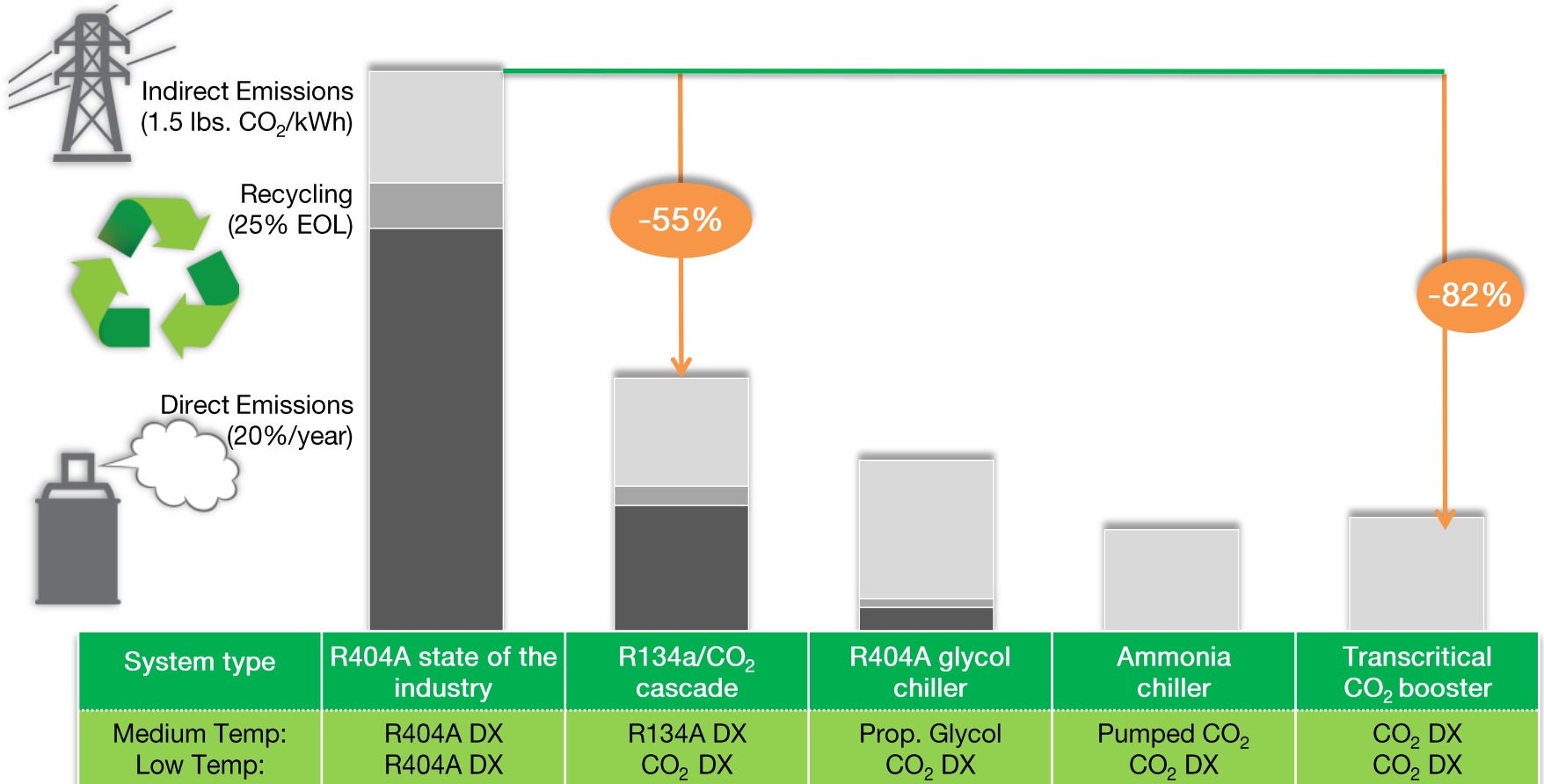


Energy Savings 10-20% possible

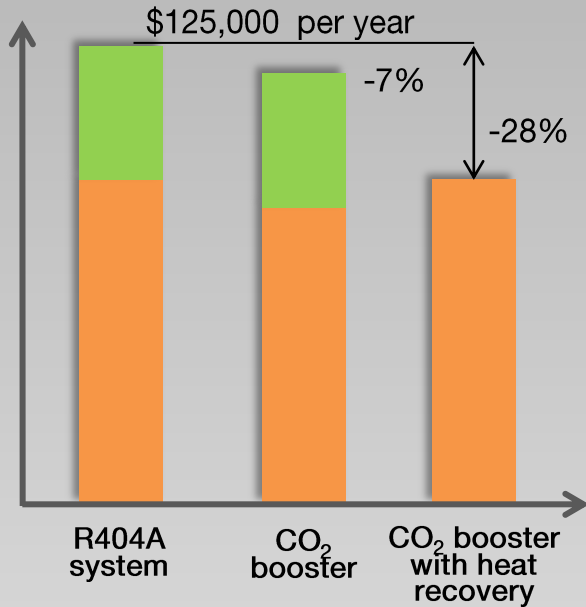
- Refrigerant properties
- Heat reclaim
- Unique algorithms
 - Rack controls
 - Case controls

Environmental Impact

TEWI Analysis of Alternative Systems (New York)



(TEWI = Total Equivalent Warming Impact)



■ Electricity : \$ 0.18 / kWh
■ Gas : \$ 1.85 / m³

- 11,000 ft² store retrofitted in 2010
- One CO₂ booster system providing:
 - 160 kW of cooling
 - 29 kW for 150°F tap water
 - 56 kW for comfort heating
- Results
 - Annual operating cost savings: **\$35,000**
 - Incremental investment for heat reclaim **<5 months ROI**
 - TEWI further **reduced 7%** by adding heat reclaim



Project: Whole Foods Market (Brooklyn, NY)

1st HFC-free supermarket in the U.S.



Store Stats:

- 56,000 ft.²
 - Plus 20,000 ft.² rooftop greenhouse
- Transcritical CO₂ refrigeration
- Combined heat and power (CHP) provides baseline electrical and heating/cooling load
- AHUs with hot and chilled water systems
- Solar parking canopy array (320kW)
- Solar and wind powered parking lot lighting

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Goals:

- 100% HFC-free store
 - Refrigeration systems
 - HVAC systems
 - Self-contained systems
- Pursuing LEED® Platinum Certification
- Achieved Greenhill Platinum Certification
- Achieved 4 Green Globes
- Participation in New York State Energy Research and Development Authority (NYSERDA) programs

Training & Industry Collaboration



Controls
provider



- Whole Foods Brooklyn project made possible through strong industry collaboration

- Contractor training was critical to project success
 - Pre-training done with OEM
- Danfoss is investing in training
 - Online training
 - Technical institutions
 - Industry partnerships

#9

Accelerating the Technology

- Significant, growing interest in CO₂
 - Supermarkets & allied industries (e.g., industrial refrigeration)
 - 80,000 stores expected to be CO₂ within the next 10 years, globally
 - Danfoss has seen interest in North America grow by a factor of 10 in the last 2 years
- Why?
 - Pending HFC phasedown
 - Energy savings
 - End users need a stable, sustainable platform
- Achieving scale reduces capital costs
 - *Technology exists today*
- ROI improves





ATMO
sphere

business case

natural refrigerants

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Thank you very much!