



Natural refrigerants in commercial refrigeration – approaches in Europe and their possible transfer to other regions of the world

- The South African example -

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Project funded by the German International Climate Initiative (ICI)

Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

- Complements existing development and international cooperation activities in the field of climate
- Uses income from the auctioning of CO₂ emission rights through the emissions trading system to fund climate protection projects
- Priority areas:
 - Increasing energy efficiency
 - Expanding the use of renewable energies
 - Reducing climate-damaging fluorocarbons
- Support is provided to both investment projects and capacity-building projects
- 120 Mio EUR per annum



Rationale for International Cooperation in the Commercial Refrigeration Sector

- HFCs are controlled substances under Kyoto
- 2007 Adjustments of the Montreal Protocol with regard to HCFCs
- 2009 → North American proposal for the Phase down of all HFCs (including so-called HFO) under the Montreal Protocol*
- Currently, supermarket refrigeration systems in Africa operate exclusively on fluorinated refrigerants with high ozone depletion potential (ODP) and/or high global warming potential (GWP) at generally higher leakage rates than in Europe (>25%).
- The use of natural refrigerants are largely unknown and seen with concern due to potential safety issues. In order to transfer technology and know-how widely used in Europe, the BMU and the South African Department of Environment and Tourism agreed to implement a demonstration project together with the supermarket chain, Pick'n Pay in South Africa.
- The project demonstrates cost effective sustainable alternatives for the commercial sector while complying with international objectives & obligations.



More information:



Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

ONE WORLD. ONE INTERNATIONAL CLIMATE INITIATIVE.

The International Climate Initiative (ICI) has been financing climate protection projects in developing and newly industrialising countries and in transition countries in Central and Eastern Europe since 2008. The International Climate Initiative receives funding from emissions trading and thus represents an innovative financing mechanism to support partner countries in the area of climate protection. With this new form of cooperation the Federal Environment Ministry supplements the existing development cooperation of the German government.



<http://www.bmu-klimaschutzinitiative.de/en/theme>



Technology Options for Supermarkets in Europe





Evolution of centralized refrigeration systems in Europe - Multiplication of systems -

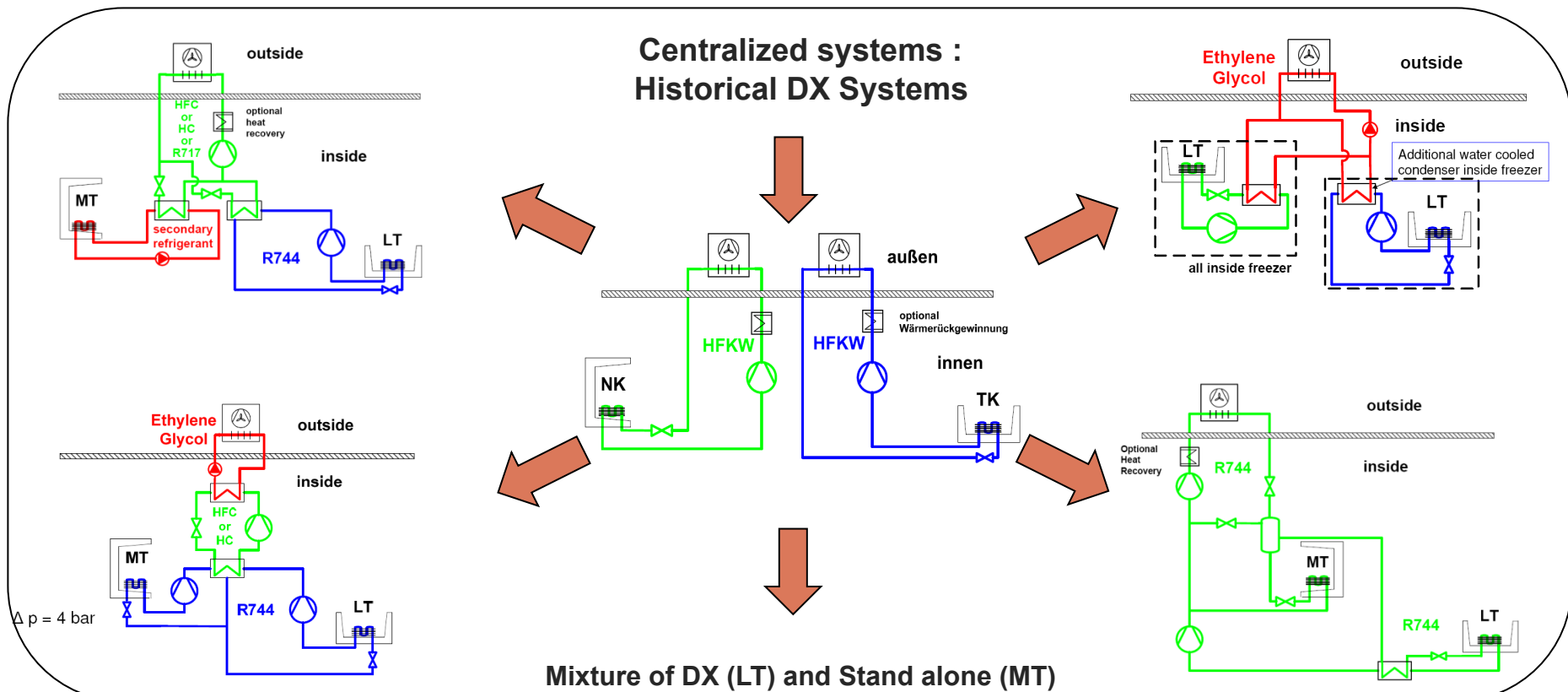
Commercial refrigeration - three different categories of systems:

- stand-alone equipment,
- condensing units, and
- **supermarket centralized systems**

Temperature ranges required :

Low temperature (LT) typically -38 °C

Medium temperature (MT) typically -8 °C





Refrigerants used in various systems

Centralised Systems	Medium temperature (MT)	Low temperature (LT)
<i>Historic: Direct expansion</i>	R22	R22
<i>Historic: Direct expansion</i>	R22	R404A
Direct expansion	R404A	R404A
Direct expansion	R404A	R744
Direct expansion	R134a	R404A
Direct expansion/cascade	R134a	R744
Indirect	R717	Liquid
Cascade	R744	R717/R744
Cascade	R744	R290/R744
Direct expansion	R744	R744
Combined Systems	NK centralised	TK Plug-in units
Direct expansion	R404A	R290
Direct expansion	R134a	R290
Indirect	R290	R290
Direct expansion	R744	R290



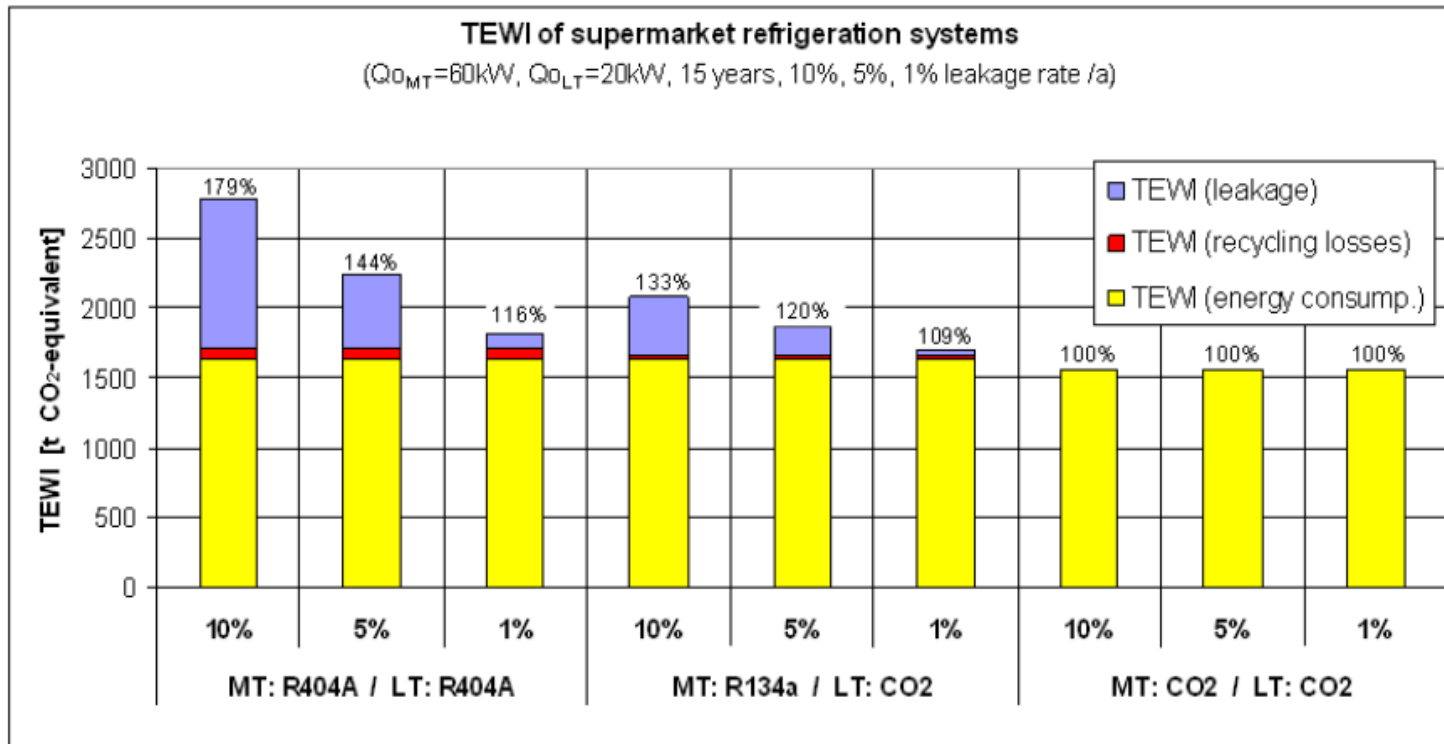
Cost estimates for various systems

Cost comparison based on R404A DX system (*)	Investment	Energy	Servicing	15 year operation
1. DX R404A NK+TK	0%	0%	0%	0%
2. DX R134a NK+R404ATK	12%	-8%	0%	0%
3. R404A NK+R744 TK	0%	0%	15%	1%
4. R134a NK+R744 TK	12%	-8%	15%	2%
5. Indirect R717	27%	15%	23%	20%
6. R717/R744 NK+TK	28%	-13%	23%	5%
7. R290/R744 NK+TK	15%	0%	0%	5%
8. DX R744	20%	0%	20%	9%

* Calculations undiscounted based on UBA-FB 001180, Ecofys, Kauffeld, Ökorecherche



Influence of refrigerant leakage on the TEWI of refrigeration systems



Filling charge:

R404A: 220kg

R134a: 210kg

CO₂: 130kg

CO₂: 25kg



Technology Criteria for South Africa and Project Description





Criteria for technology selection

- Leakage rates are higher in South Africa also in new systems (~25%), refrigerant choice of critical importance for climate impact
- Higher mean ambient temperatures compared to Europe, at a level where transcritical CO₂ für MT not recommended by suppliers (>15°C)
- Refrigerant availability, preferably technology experiences exist
- Energy consumption equal or lower local state of the art installations

Cascade system 717/744

- **MT**: indirect NH₃ with glycol-water solution ; **LT** CO₂
- NH₃ technology locally known (industrial refrigeration), CO₂ available,
- Integration combines the best of CO₂ LT and indirect MT refrigeration.
- Selection back in 2008, today the system is increasingly used in Europe and state of the art for centralized refrigeration.



Pick`n Pay readily agreed to try the new technology and to convert the refrigeration systems of two supermarket stores in different climate zones of South Africa, in Johannesburg and in Cape Town. Pick`n Pay contributed the replacement of all refrigeration units and other parts of the installations on their own cost.

The new technology is a cascade system with ammonia as the primary system and a glycol-water solution for distribution inside the store. The CO₂-cascade, as the secondary system, provides the cooling for the low temperature applications. Both systems are located in a machine room on the roof tops of the buildings.

As part of the project design, the technology was installed by South African refrigeration companies. This ensures that the technology can spread more easily once its advantages are proven.





Target Groups :

Supermarkets, Associations, Technicians, relevant international committees

Project budget : 1,4 Mio EUR co-funding

Project partners:

SA Department of Environment and Tourism;
Pick'n Pay

Site selection

Capetown (medium amb. Temp.)

Gauteng (high amb. Temp.)

Expected environmental impact:

2000 t CO₂eq/year compared to
the existing installation

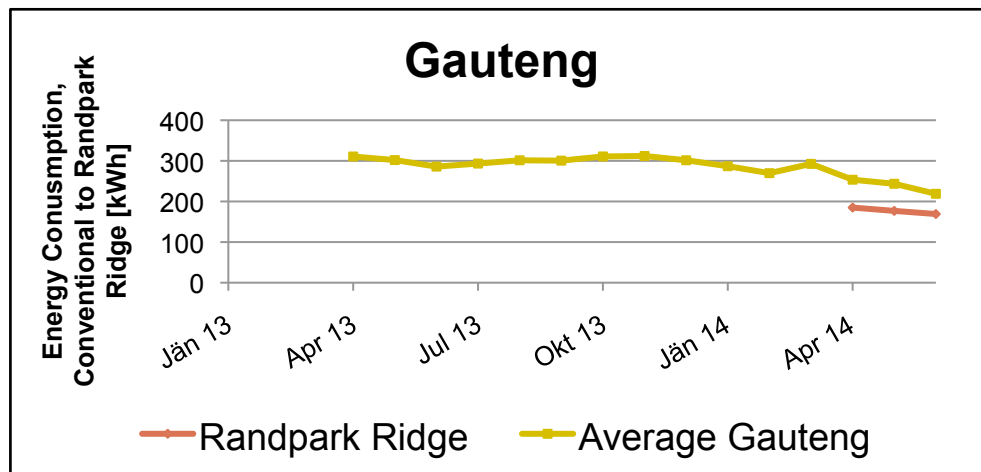
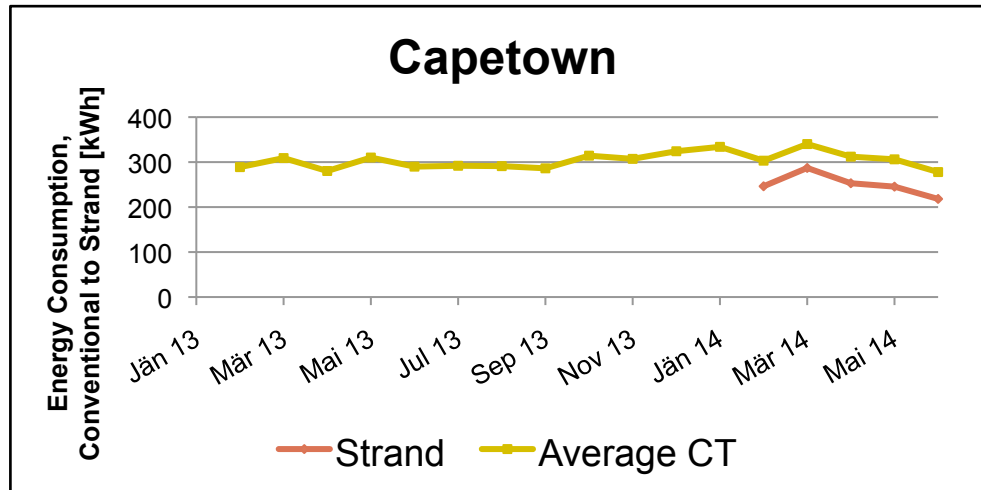




First Results and Conclusions of the Supermarket Conversion in South Africa



Results of Energy Efficiency Measurements



The refrigeration systems in the project stores use between 19% and 26% less energy per month as compared to the average of newly installed conventional refrigeration systems in reference stores.



Greenhouse Gas Emission and Electricity Savings

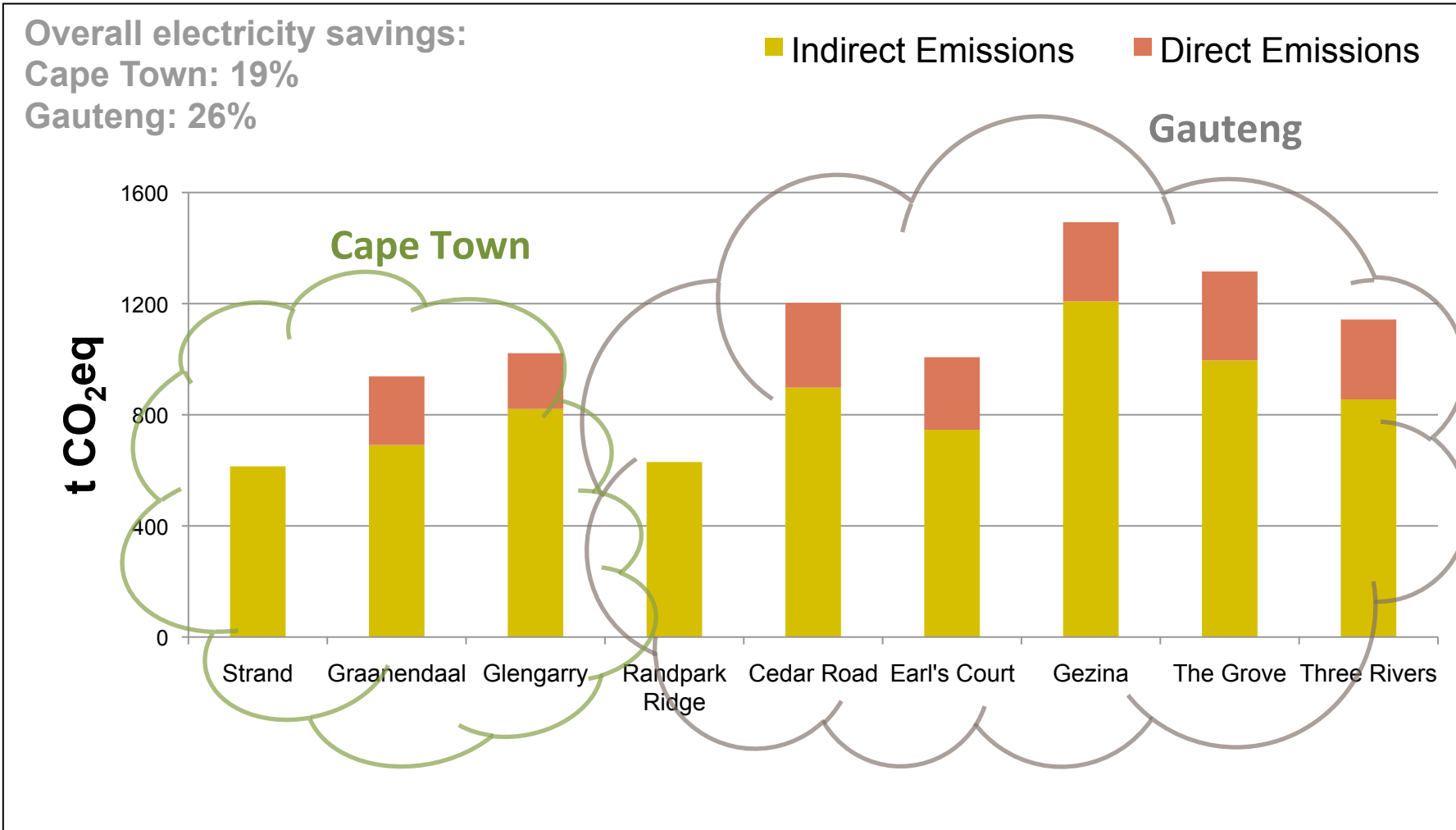
(overall calculated averages between project stores and new conventional stores)

	Strand Capetown	Randpark Ridge Gauteng
Energy consumption reduction	19%	26%
Energy savings (MWh / year)	173	132
Indirect emissions (tCO ₂ /year)	161	122
Refrigerant emissions avoided (tCO ₂ eq/year)	234	340
Total emission elimination (tCO₂eq/year)	395	462

Compared to the old replaced systems the project will eliminate emissions of ca. 2000 t CO₂eq/year !



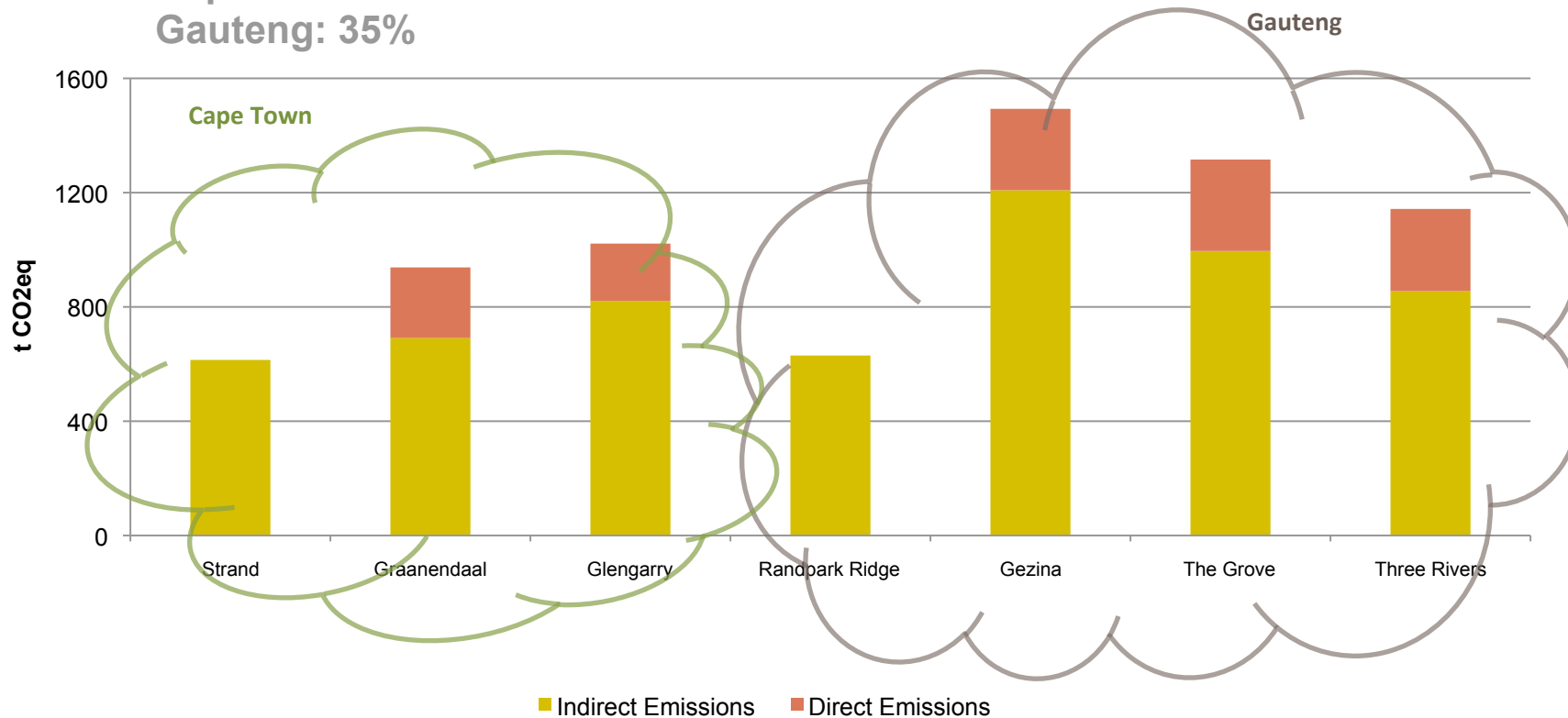
Comparison of similar markets in the region with new installation vs. refurbished project stores





Comparison of old buildings refurbished with conventional refrigeration technology vs. refurbished project stores

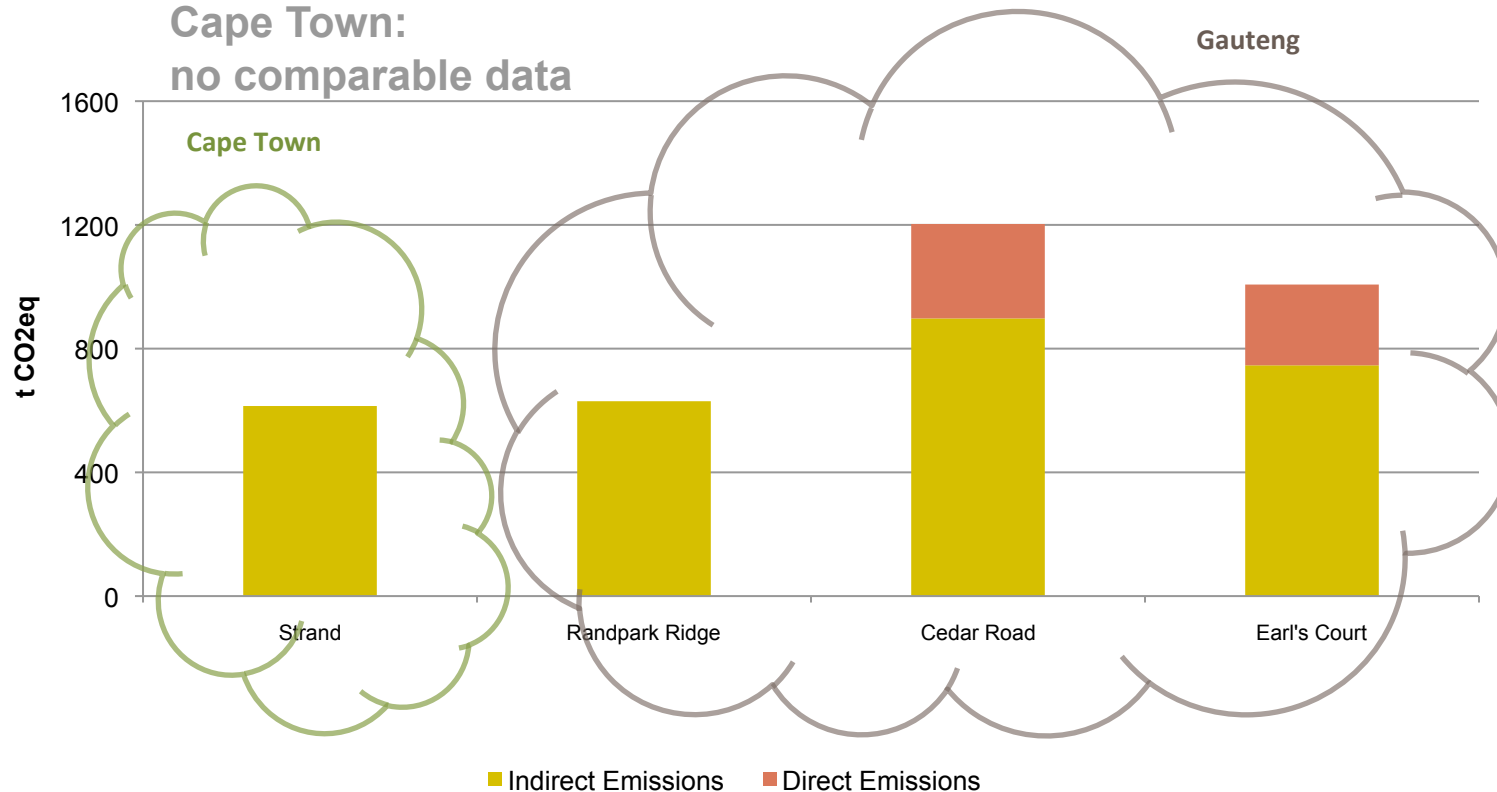
Electricity savings:
Cape Town: 19%
Gauteng: 35%





Comparison of newly build Supermarkets vs. the refurbished project stores.

Electricity savings:
Gauteng: 6%
Cape Town:
no comparable data



Conclusions



- Conversion of commercial fluorinated refrigeration to natural refrigeration technology entails massive greenhouse gas emissions reductions, because of high leakage rates in South Africa .
- Apart from the huge savings of direct emissions, natural refrigerants prove to provide better energy efficiency in comparison to the local state-of-art technology and save min. 35% if compared with old installations.
- Ammonia is a known technology from industrial refrigeration. CO₂ is also easily available. The selected system is appropriate both in Europe and Africa and indicates high potential for broad application and cost effective diffusion for most parts of the world.
- First replications of pilot project under way. Pick'n Pay and other chains announced they like the concept and plan to multiply installations. Similar demonstrations have been requested under the Multilateral fund.
- Cost premium of 30 % upfront might become an obstacle for smaller investors, specifically outside South Africa. Better financial assistance could possibly enhance wide spread conversion.



Thank you!

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