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Environmental Investments


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The new hot thing: The Cold Economy

Is there anything in common between a recent test of a subsea based server run by Microsoft off the coast of California and the World Expo 2015 theme “Feeding the planet, energy for life” held in Milan? What is the connection between a LNG tanker travelling from Australia to Japan and the record sales of air conditioners in China in 2014? Most readers would probably consider these questions merely provocative and probably meaningless. Nonetheless the events have actually much more in common than meets the eye.

The experimental efforts of Microsoft to reduce its energy impact, the explosion in sales of air conditioning units in China, the movement of a refrigerated tanker across the world and the fight against hunger represented by the World Expo theme are unified by a single theme: the Cold Economy.

Cold technologies: centuries in the making with further growth to come

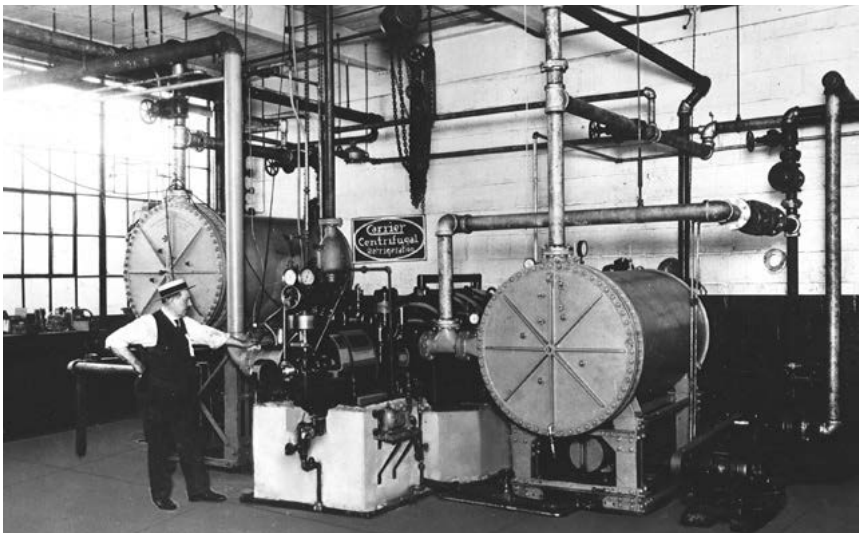
The "Cold Economy" refers to the delivery of solutions to reduce temperature for comfort, food conservation or industrial processes. Beyond the intuitive air conditioning sector, there are several other sectors which fall under the wider "refrigeration" theme. The main discriminant between air conditioning and refrigeration is one of temperature: the refrigeration sector typically includes solutions that can reach much lower temperatures than those provided by air conditioning. Refrigeration equipment is used in cold chains for a variety of purposes, including food conservation, cooling of IT devices such as in data centers, in industrial processes to reduce the temperature of working fluids, or even in cryogenic applications where temperatures lower than -150°C are required. The refrigeration and air conditioning industry (RAC) is estimated to generate more than $100 billion of economic activity annually worldwide. Within Europe alone, there are thousands of companies catering to this industry, from equipment and component manufacturers to, service providers and engineering companies.

The range of applications of "cold science" has increased exponentially over the past two centuries, but been in existence for a significantly longer period of time, prior to formally being a science. Historical signs of icehouses are ancient, demonstrating a need to preserve food long before 7-Eleven convenience stores spread globally or fresh Argentinian meat was imported to European consumers. In Mesopotamia they date back to around 1800 BC, in China around 700 BC and in the 3rd century AD in Rome there were ice shops trading imported snow and ice from the mountains. Yet despite the wide diffusion of icehouses through to the mid-19th century, no significant technological improvements were made. This all changed in 1824 when Michael Faraday discovered the principle of vapour absorption, demonstrating that liquefaction of ammonia reduces temperatures. In the following 100 years, many inventors contributed to develop this technology further. To name a few:

- Ferdinand Carré, who developed the first gas absorption refrigeration system using gaseous ammonia dissolved in water (1859);
- Willis Carrier, who invented air conditioning (1902) and founded the Carrier Corporation (1915), which remains one of the largest air conditioning manufacturers in the world;
- Thomas Midgely, who discovered CFC gases at GM to find a less explosive and flammable refrigerant than ammonia (1928); and
- Frederick McKinley Jones, who designed a portable air-cooling unit for trucking perishable food (1935).

By 1939, over two million American homes owned a refrigerator. Diffusion of air conditioning made hot regions like the Sun Belt in the US more habitable and economically viable. Today, 88% of US population growth to 2030 is expected to come from this region. Diffusion and dispersion of these devices has been continuous and worldwide: in 2010

Willis Carrier and the first air conditioning. Courtesy Carrier Corporation



India has a severe shortage of refrigerated vehicles: a worker uses a rickshaw to transport ice from a factory in Amritsar
Photo: Narinder Nanu/AFP /Getty Images

Chinese consumers bought around 50 million air conditioning units, half of the US domestic air conditioner fleet.

Moreover, the technological development of cooling equipment has enabled further innovation across industrial processes: cooling of ammonia is a crucial step at the core of fertilizer production; cryogenic technologies enabled the development of MRI (Magnetic Resonance Imaging) since scanners could not work without the extreme cold of liquid helium; and temperature sensitive medicines, like the world's biggest selling anti-cholesterol drug – *Lipitor*, could be developed and shipped safely to consumers.

Spig, Ambienta's portfolio company, which designs and build cooling towers, represents a key evidence of the application of the same physics principles in large scale cooling of power generation and other sectors' equipment.

Today several long-term drivers support the continued expansion of the RAC industry, which is underpinned by both environmental awareness globally and improving living standards in developing economies, which demands an improved ability to preserve food and raise hygiene standards. Outlined below are some examples of clear areas of growth:

- **Cold Chains:** In India just 4% of perishable goods are transported via cold distribution chains versus more than 90% in UK. India would then have to grow its fleet of TRUs (Transport Refrigerated Unit) 18 fold to reach the UK's penetration of TRUs by value of the national food market. Growth could be even stronger if measured relative to penetration by population: to reach the UK equivalent, India's fleet should grow over 100 fold.
- **Air conditioning:** Despite high penetration in developed economies, it is not common in many parts of the world. In India penetration of air conditioning is just 5%, compared to c. 80% in the US.
- **IT driven applications:** Data centers consume around 2-3% of UK electricity; of this, around 50% is used for cooling systems. Between 2007 and 2013 alone, the power consumption of global data centers quadrupled. As Internet and mobile applications grow, computing and digitalization of services will spread further and require more cooling equipment for data centers.
- **Medicine:** Growth of disposable income will improve access to medicines and treatments. Many medicines require a refrigerated chain to remain effective while cryogenic technology is often needed to enable the manufacture and operation of diagnostic equipment.
- **LNG:** Despite current shocks across energy markets, gas and specifically LNG trade is forecasted to grow significantly over the next decades, reflecting its widespread availability as a fuel source and insulation from political instability. Critically, the storage and transportation of LNG requires industrial scale cooling.

Combined, these trends and drivers point towards a long term growing sector, which today shows a healthy global average CAGR of 6-7%, with emerging economies rates skewed towards 10% and niche markets able to deliver clear double digit rates (i.e. China refrigerated transport 20-25% per year).

Environmental impact: a simultaneous threat and a source of opportunities

As with many human activities, the Cold Economy has substantial environmental impacts. The two main are leakages of refrigerants from cooling equipment and emissions (i.e., CO_2, NOx, PM) of power stations supplying electricity. Since these two impacts are far larger than often perceived, regulators have been focusing on them recently and environmental regulation has been promoted in order to: i) change the type of refrigerants (pollution control); and ii) make the RAC equipment more efficient (energy efficiency).

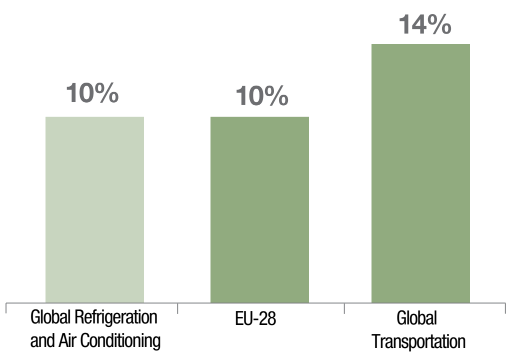
Family	Name	Refrigerant Number	ODP Ozone Depletion Potential	GWP Global Warming Potential
CFCs	Chlorodifluoromethane	R22	0,05	1.810
	Freon	R12	1,00	10.900
HFC		R404a	0	3.922
	Tetrafluoroethane	R134a	0	3.790
Natural Refrigerants	Carbon Dioxide (CO_2)	R744	0	1
	Isobutane	R600a	0	4
	Propane	R290	0	3
	Ammonia	R717	0	-
	Water	R718	0	-

Major refrigerants GWP and ODP coefficients

Pollution control. The impact of refrigerants as environmentally damaging agents has been significantly under scrutiny for decades, since at least 1974 when the link between CFC refrigerants and ozone layer depletion was proposed. The Montreal Protocol of 1989, the first ever universally ratified treaty of the United Nations, planned the phase out of these gases. The industry adjusted moving to HFC gases, with no ozone impact, but with a Fluor content (F-gases) that makes them highly potent greenhouse effect contributors. The most commonly used F-gas, R404A, is almost four thousand times more powerful than carbon dioxide in terms of greenhouse effect. This means that a leakage of 1kg of refrigerant during maintenance of a refrigerating system emits as much as 4 tonnes of CO_2, or as much as the annual emissions of two passenger cars. For this reason, the EU has introduced several F-gas regulations that will progressively phase out HFC gases in favor of natural refrigerants which occur in nature, like ammonia, hydrocarbons or CO_2 itself. High quality engineering of refrigerating systems and the development of specific components (i.e. high-pressure compressors) are enabling increasing adoption of natural refrigerants.

Regulation and engineering development are expected to drive down volumes of F-gases in Europe by 80% by 2030. However, F-gases represent around 25% of total global warming impact of the sector with energy consumption representing the remaining 75%.

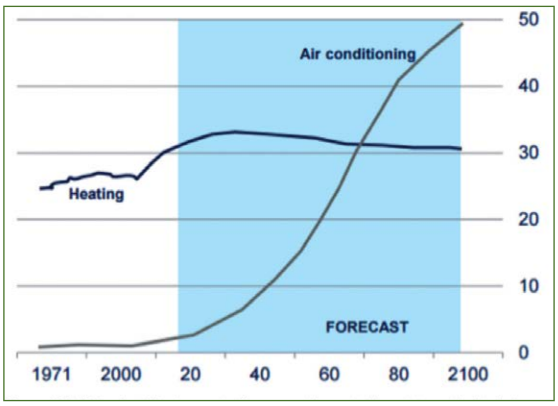
Energy efficiency. Driven by the phasing out of HFCs, energy contribution to the total greenhouse emission of the RAC sector is expected to jump to 90% by 2030. In the absence of official estimates of the energy consumption of the RAC sector we have to rely on private analysis and estimates. The London South Bank University has estimated that RAC consumes around 16% of UK electricity and is responsible of 10% of global CO_2 emissions, three times more than aviation and shipping combined. The German government has estimated RAC to account for 7% of the total energy consumption. One estimate is that worldwide RAC emissions are equal to the EU-28 emissions from all sources (i.e. 10% of worldwide emissions) and not much below the estimate for worldwide transportation emissions of 14%.



Percentage of total global CO_2 emission by source

LNG tanker docked in port

The sector's expected growth described above will be reflected in energy demand: the German government estimates that RAC's share of total electricity demand will double from 7% to 13% by 2030, supported by increasing penetration and changing consumption patterns. As daily peak temperatures are likely to rise in the decades ahead, RAC equipment is expected to work more often at so called "partial load", a function where the equipment is typically less energy efficient. As a result researchers expect the energy demands of cooling to exceed those of heating by 2060.



Word forecast energy demand for space heating and space cooling. Source: PBL, Netherlands Environmental Assessment Agency

Additional energy demand will not be supplied only by grid connected power. Transport refrigerated units (TRUs), for example, very often are powered from diesel generators separate from the propulsion engine. These auxiliary engines in Europe are unregulated, inefficient and highly polluting, thus contributing to the broad environmental impact linked to energy demand. TRUs can emit up to six times more NOx and 29 times as much PM (Particulate Matter) as a Euro VI truck propulsion engine.

Fortunately, cooling technologies also provide opportunities for reducing environmental impact, as refrigeration contributes in positive ways to improve efficiency of natural resources and reduce pollution. It is estimated by the International Institute of Refrigeration that if developing economies employed the same "cold chain" as developed ones the world could save around 200 million tonnes of perishable food (14% of food world supply). When one considers all the resources put in growing food (eg, water, fuel for agricultural machines, fertilizers), food wastage is estimated to be the world's third biggest CO_2 emitter after the US and China! Food wastage consumes agricultural land the size of Mexico and three times the water of Lake Geneva. Saving 14% of the global food supply would therefore considerably contribute to the world's wellbeing and to its economic efficiency.

In conclusion, the industry of cold technologies represents both a threat and a solution to the environment.

Investing in the Cold Economy: environmentally and financially sound

Business decisions will have to be made within the framework of energy and pollution regulation policies. Moreover proper investment decision making can drive further energy efficiency across the industry. Since refrigeration represents anything from 50% of total energy cost in the meat processing industry, to up to 70% in 7-Eleven convenience stores and 90% in cold storage facilities, making an effective investment decision on cold technologies and how to manage them can make a great difference from both a financial and an environmental perspective. For example, the maximum efficiency of vapour compression refrigeration is around 60% but the average achieved is only 30%. Similarly, natural refrigerants, even if they require higher initial capital expenditure, can provide viable economic cases in specific applications or conditions, due to higher efficiencies. CO_2 systems for example, command c. 10% higher capex than comparable HFC systems but can provide significantly higher efficiencies, thus lower opex, in climates with limited high temperatures. These examples highlight the natural alignment of both environmentally and financially sound business decisions.

As a matter of fact, solid underlying drivers, innovation, both disruptive and marginal, and regulation open up a wide range of opportunities. Therefore we believe a sustainability focused investor should devote time to understand where to invest across the value chain, in which application markets and along which technology development.
For convenience, we can group investment opportunities in five areas which together combine to form a global industry worth over $100 billion:

- **RAC equipment manufacturers:** Designer and manufacturers of refrigerating or conditioning equipment with different degrees of specializations in terms of technology, application, geographic scope (i.e. heat pumps, chillers for process industries, data center conditioning systems, natural refrigerant specialists, refrigerating equipment for transport applications, cabinets for supermarkets).
- **Component manufacturers:** Compressors, valves, heat exchangers, condensing pumps, insulation material, lighting components and other components manufacturers.
- **Electronic control systems:** Manufacturer of electronic controllers to improve and control anything from a single simple air conditioning unit up to the complete set of air conditioning and refrigeration system of a skyscraper. Adapting work of appliances to actual demand, load and usage patterns can significantly increase equipment efficiency.
- **Maintenance and installation services:** Companies providing maintenance services on installed base. Recent estimates confirm that regular maintenance of equipment can provide up to 20% energy cost saving.
- **Refrigerants management business:** Mainly service businesses providing handling, substitution and safe disposal of harmful or polluting refrigerants. Even when HFCs are completely phased out, other chemicals are likely to have emerged and regardless, natural refrigerants, which are highly flammable, will need to be handled in safe conditions.

Each potential target group represent a different competitive sector that is influenced differently by industry specific trends (eg. shift in refrigerants, search of energy efficiency) or by broader trends in adjacent industries, such as connectivity of equipment to the Internet (i.e. Internet of Things -IoT-) or the adoption of demand and response solutions to enable grid stabilization.

In light of the initial development of cold technologies as well as early regulatory pressure on refrigerant gases, the US and Europe

present key geographies in which to look for competencies in this sector. Some areas of Europe are particularly interesting, like Italy, where traditionally higher than average energy prices have in turn promoted the development of high efficiency RAC equipment. For example, Italy has a long tradition of electronic controls design and manufacturing which is and will increasingly be crucial to drive energy efficiency in complex, web-connected and remote controlled installations. Emerson Climate Technologies and Schneider Electric, two major players in this arena, hold long standing centers of competences in the north east of Italy, due to acquisitions completed more than a decade ago.
In the UK there is a strong competence center for cryogenic technologies, exemplified by Siemens Magnet Technology, the world's largest supplier of superconducting magnets for MRI (Magnetic Resonance Imaging) equipment, with 30% global market share.
The industry as a whole sees a continuous stream of M&A activity driven by technology acquisition, market entrance strategies, both in terms of geography or vertical applications market, consolidation or even restructuring.

with its electronic controls division and LED manufacturing businesses, that are instrumental to obtain higher energy efficiencies. The same happened with the Mitsubishi Electric acquisition of DelClima, which was completed at an 83% premium over the listed share price, primarily to enter the European market and access DelClima's extensive experience on data centers cooling technologies.
The acquisitions of Advansor and SCM Frigo highlight the interest toward engineering capabilities of highly innovative refrigerators using CO_2 as a refrigerant. Adoption of CO_2 systems has recently taken off in Europe in supermarket chains, with sales expected to more than double in the next few years, in Japan and even in the US, in light of restrictions imposed on the R-404a refrigerant.
Each transaction showcased here has a different story and background, but we are able to draw the following conclusions about the Cold Economy:

- Private equity investors can find highly attractive investments opportunities.
- Industrial buyers represent an interesting exit for financial sponsors.

Reference M&A transactions

Target company	Description	Buyer	Year	EV ($m)	EV/ Revenues	EV/ EBITDA
Del Clima (ITA)	RAC Eq. manufacturer, industrial and IT cooling focus	Mitsubishi Electric	2015	730,4	1,9x	14,1x
Hussman Corporation (US)	RAC Eq. manufacturer, supermarket cabinets	Panasonic Inc.	2015	1.545,0	n.a.	n.a.
Nuaire Limited (UK)	RAC Eq. manufacturer, ventilation systems	Polypipe Ltd	2015	228,8	2,3x	11,0x
SCM Frigo (ITA)	RAC Eq. manufacturer, CO_2 specialist	Beijer Ref	2014	n.a.	n.a.	n.a.
Frigoblock (GER)	RAC Eq. Manufacturer, TRUs	Thermo King -Ingersoll Rand	2014	110,0	2,7x	n.a.
AHT Cooling Systems Gmbh (AUT)	RAC Eq. Manufacturer, Supermarket cabinets	Bridgepoint	2013	760,0	2,0x	13,1x
Advansor (DEN)	RAC Eq. manufacturer, CO_2 specialist	Hill Phoenix (US)	2011	n.a.	n.a.	n.a.
Tecumseh Product Company (US)	Components manufacturer, compressors	Atlas Holdings	2015	142,0	0,2x	7,5x
Aspen Pumps (UK)	Component manufacturers, condensing pumps	3i Holdings	2015	160,0	n.a.	10,7x
Single Temperiertechnik Gmbh (GER)	Electronic control systems, temperature control	Single Group	2015	24,2	0,7x	8,8x

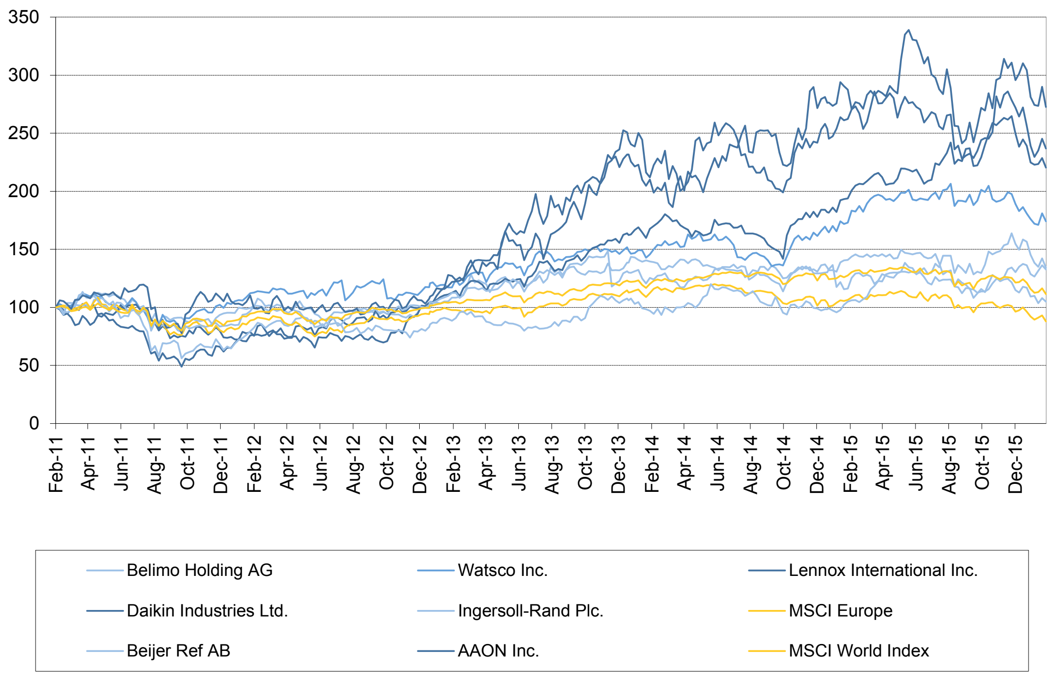
Some of these transactions follow a market entry strategy: for example, Panasonic entered the US refrigeration equipment for food distribution through the acquisition of Hussmann. This acquisition will allow Panasonic to broaden its air conditioning experiences and capabilities in the refrigeration arena and obtain synergies

- The industry offers a broad range of investment opportunities of practically any size range.
- The rate of innovation in the industry allows investors to take longer term positions on technologies (i.e. Advansor).
- Multiples for attractive assets tend to be fairly rich.

Among listed equities, finding pure play assets is relatively difficult because many companies are part of larger entities: Carrier is today part of United Technologies Group, which is also very active in aerospace and defense activities; Emerson Climate Technologies is part of Emerson; and Danfoss holds a diversified product portfolio (as do large multi-nationals including Mitsubishi Electric, Panasonic, Samsung and Schneider Electric).
We have selected a few pure play companies, covering different parts of the value chain or of the available sub segments. In recent years they have generally outperformed market indices, in some cases by a very large extent.

Overall we consider the Cold Economy an attractive sector for investment. A sector where scarcity of pure play listed businesses, paves the way for private investment as the natural mean to capture the growth opportunity.
A sector where positive macroeconomic drivers intersect with serious environmental threats and regulation efforts. A sector where a sustainability focused investor can simultaneously drive huge positive environmental and social impacts and solid long term value creation for shareholders.

RAC equipment selection of listed equities: 5y price performances



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