

Refrigeration and Air Conditioning Energy Efficiency & Emissions Reduction

Australian Institute of Energy May 2015

Refrigeration & Air Conditioning (AKA HVACR)

Purpose:

1. Trends in HVACR regulation & technology
2. Sources of HVACR energy efficiency
3. Implications for specifiers

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1. Trends in HVACR regulation & technology
2. Sources of HVACR energy efficiency
3. Implications for specifiers & ESCOs

How to deliver high returns on HVACR investments & retrofits.

Outline

- I. HVACR in Australia
- II. The Role of Refrigerants
- III. Global Regulations & Change
- IV. Transition to high efficiency, low emissions
- V. Sources of HVACR Energy Efficiency
- VI. Indicated actions

I. Refrigeration & Air Conditioning In Australia

The HVACR Industry serves everyone:

***commercial, residential, industrial, transport
food, hospitality, public facilities, health care....
everyone, every where!***

- 53* million individual HVACR installations (\$100B),
- 2% of GDP (\$26B spend, \$6B capital investment PA)
- **22% of electricity**, (\$14B PA, 10% of national emissions)
- **12 /14 %+ of national GHG emissions** (2/4% direct emissions, synthetic refrigerants, HCFC / HFC)*
- 20,000 firms, 200,000 direct employees, 70,000 licensees - tradesmen

Source: Cold Hard Facts 2, Dept. of the Environment 2013 ,* adjusted by ARA

I. HVACR Sectors In Australia

HVAC

Installations

Domestic & Low Rise Commercial – Split Systems	12,000,000
Commercial Chillers	30,000
Industrial chillers and splits	100,000
Cars and Trucks	12,000,000

Refrigeration

Domestic fridges and freezers	17,000,000
Commercial display cabinets, vending	1,000,000
Industrial, Manufacturing refrigeration	80,000
Grocery Stores	10,000
Cold Stores	100,000
Transport	29,000
Hot Water & Heat Pump	11,000,000

Electricity consumption by major class (PJ)

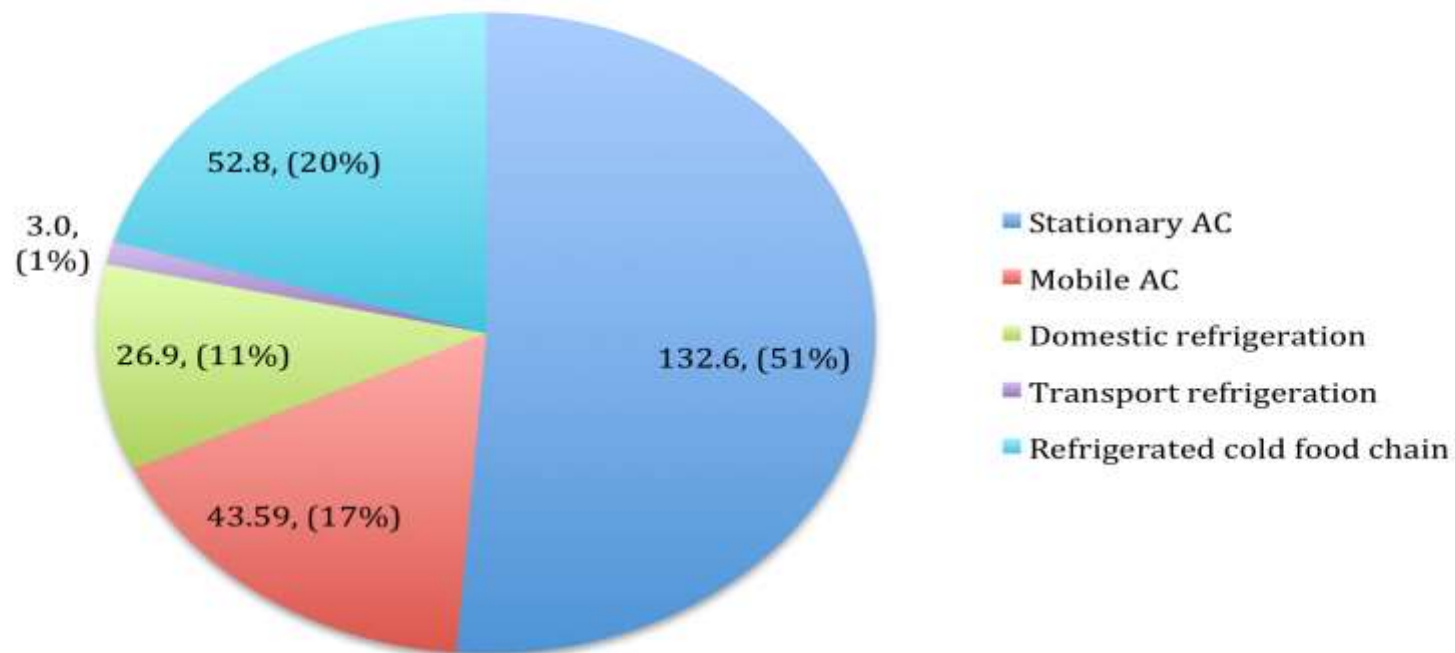


Figure 1: Energy consumption by major class in PJ and per cent of total

Electricity consumption by major class (Mt CO₂-e)

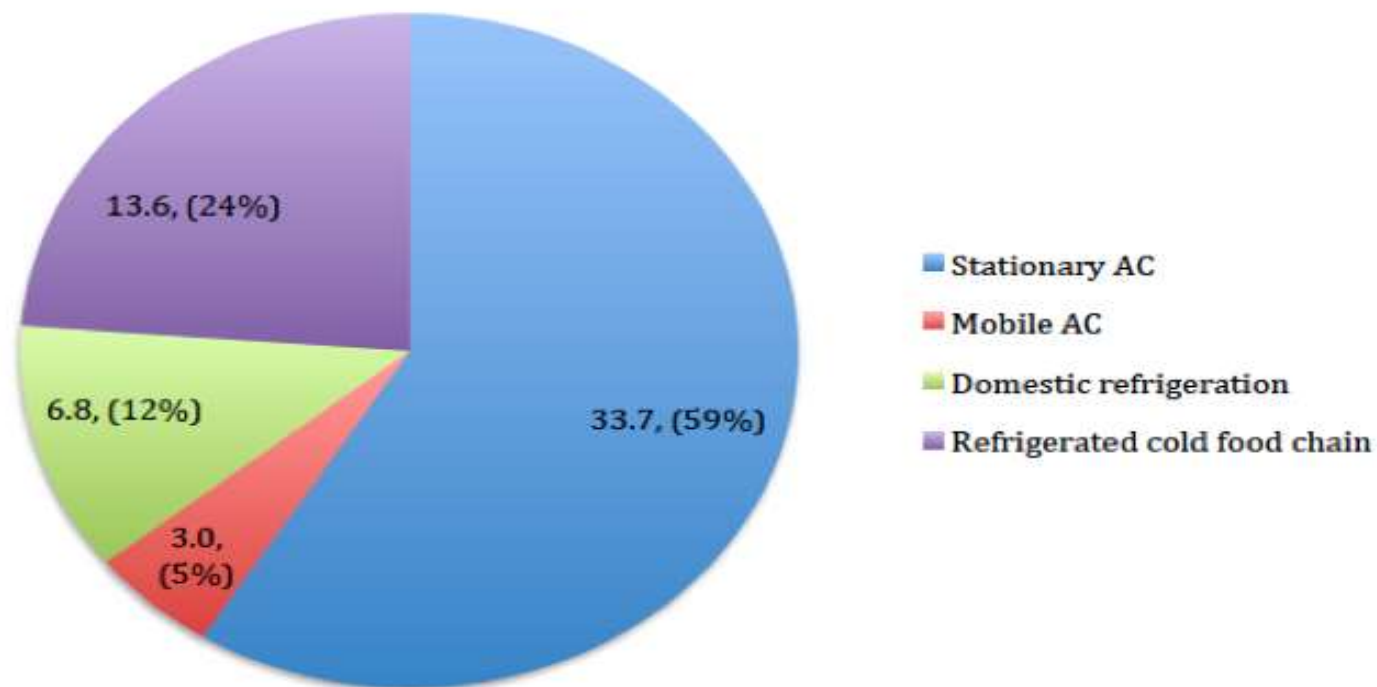


Figure 17: Indirect emissions by major class in Mt CO₂-e and per cent

(Source: CHF2 stock model)

Electricity consumption by building type (PJ)

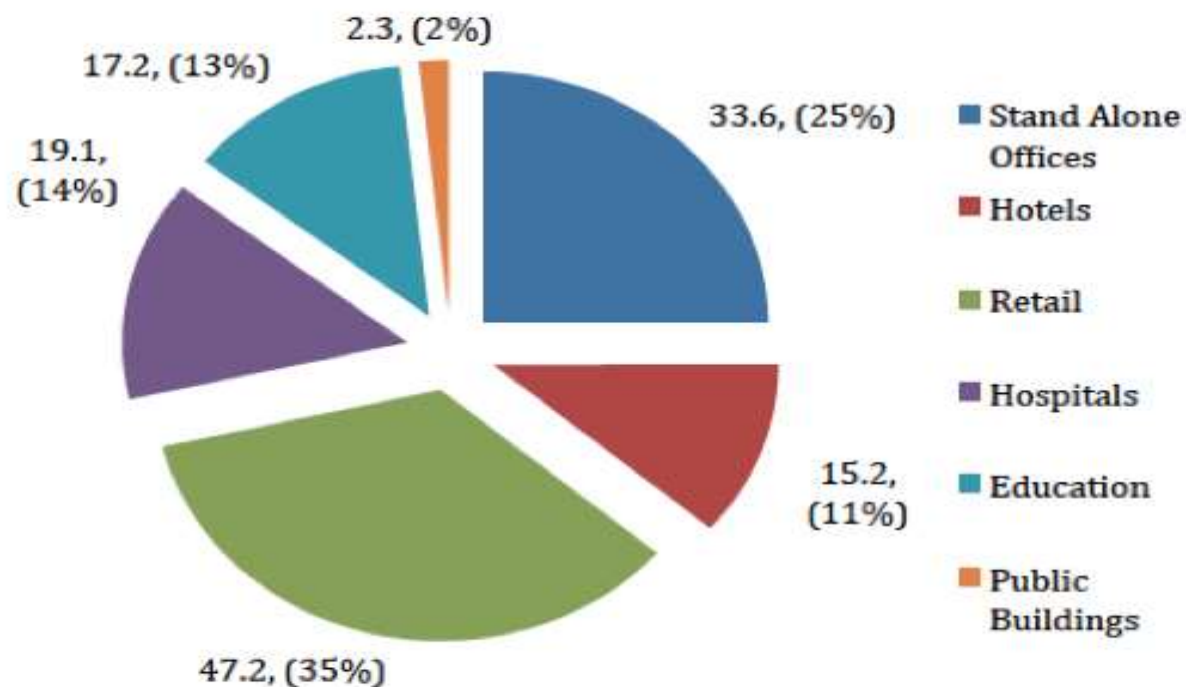


Figure 18: Total energy consumption by building type in PJ and per cent

(Source: DCCEE 2012b, CBBS Volume 1, page 5)

II. The Role of Refrigerants



Two sides of the same coin

Energy Efficiency



Refrigerant selection is the primary determinant of HVACR efficiency, Indirect emissions

10% of Australian Emissions
70% of HVACR emissions

Therefore: **When you choose an HVACR plant you choose both Direct and Indirect Emissions**

GHG Emissions

Refrigerant leakage is an understated, growing source of Direct emissions

4% of Australian Emissions
30% of HVACR emissions

II. The History / Future of Refrigerants

Danfoss: “three main parameters which must be aligned to accomplish a real sustainable balance: **affordability, safety and environment**”.

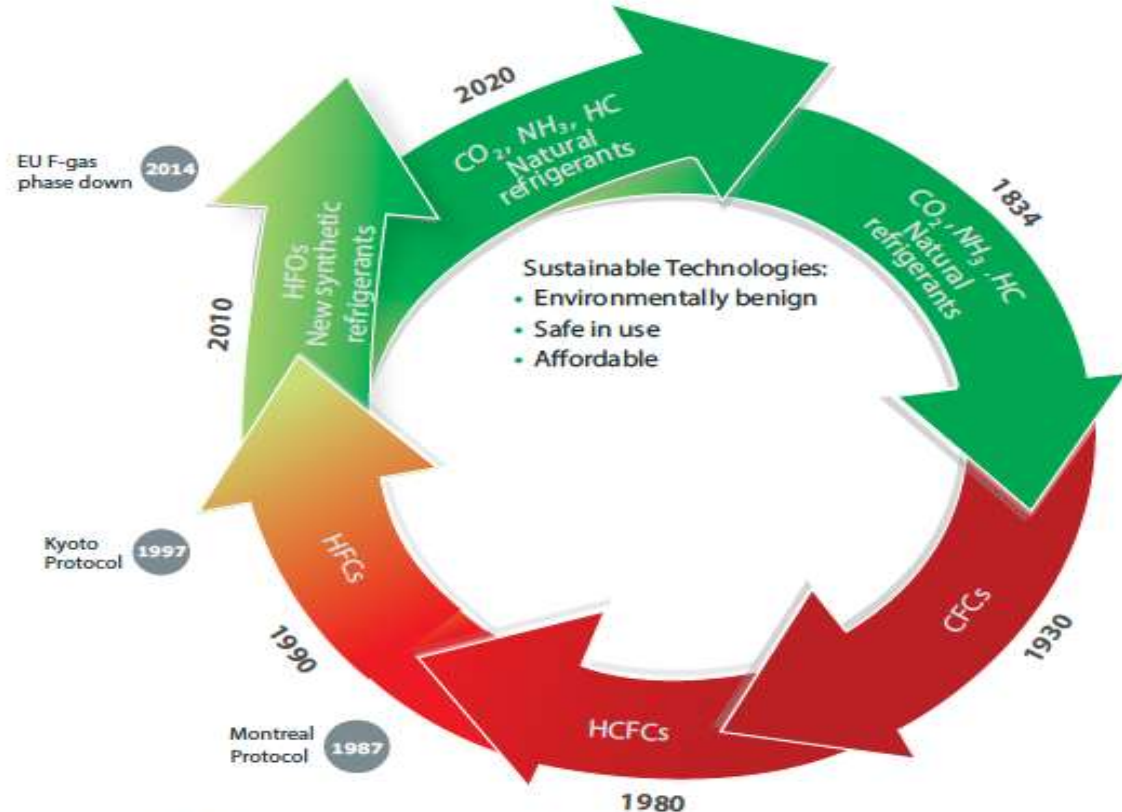
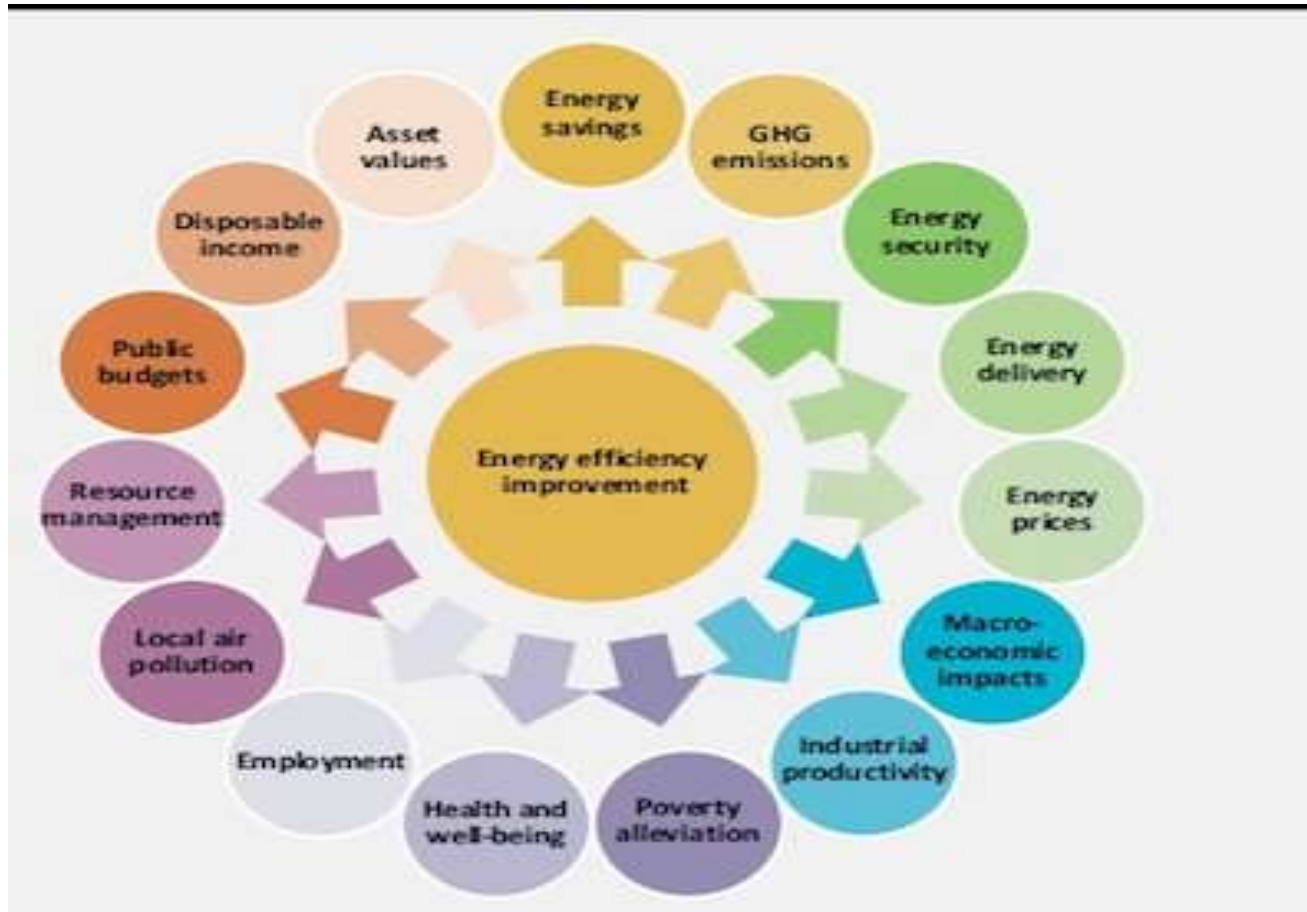


Figure 1: The historical cycle of refrigerants

Energy efficiency is the least cost source of emissions reduction and a great deal more.



Source: International Energy Agency

II. Refrigerants glossary– the alphabet soup of HVACR

Synthetic Refrigerants

CFCs / HCFCs: fluorocarbon refrigerants, ozone depleting
High GWP – 1500 / 23,000 times CO₂

HFCs: fluorocarbon, High GWP, not ozone depleting

HFOs: fluorocarbon, Low GWP, not ozone depleting

Natural Refrigerants: Ammonia, CO₂, Hydrocarbons, air, water
very low / no GWP, not ozone depleting
far more energy efficient.

II. Current International Agreements:

- **Montreal Protocol:** discontinuing the use of ozone depleting refrigerants: CFC, HCFC
- **Kyoto Protocol:** GHG accounting includes only High GWP HFC refrigerants,
- **Note the Gap:** MP emissions excluded, not counted !
 - Average HFC atmospheric life is 21 yrs !!!!
 - Average HFC 20 yr GWP is 2X100 yr GWP
 - Kyoto understates HFC and CFC / HCFC emissions
 - Plus a good deal more understatement like end of life

II. Refrigerant Regulations Are Changing Rapidly

Article Five
(industrialized)

Non Article Five
(developing countries)

CFC,HCFC banned 2020
(Australia effectively phased out 2015)

banned 2030

HFC reduced to 21% of current by 2030 / 35

III. A Global Industry

- Original Equipment Manufacturers (OEM) multinationals: China, Europe, US
- Standards are global: ISO
- Australia imports all synthetic refrigerants, locally sources natural refrigerants.

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- Original Equipment Manufacturers (OEM) multinationals:
China Europe US
- Stand ***United States, China, India and Leaders of G-20 Countries
Announce Historic Progress Toward a Global Phase Down of
HFCs***
- Australia imports all synthetic refrigerants, locally sources natural refrigerants.

III. Refrigerant Regulations Are Changing Rapidly & Fundamentally

The G-20 agreement on HFCs reads as follows:

“We also support complementary initiatives, through multilateral approaches that include using the expertise and the institutions of the Montreal Protocol to phase down the production and consumption of HFCs, based on the examination of economically viable and technically feasible alternatives”.

Read More: - <http://www.epa.gov/ozone/intpol/mpagreement.html>

III. Refrigerant Regulations Are Changing Rapidly & Fundamentally

Presidents Obama & Xi Jinping, PM Modi

“ We reaffirm our announcement on June 8, 2013 that the United States and China agreed to work together and with other countries through multilateral approaches that include using the expertise and institutions of the Montreal Protocol to phase down the production and consumption of HFCs, while continuing to include HFCs within the scope of UNFCCC and its Kyoto Protocol provisions for accounting and reporting of emissions”.



- To Reduce Short Lived Climate Pollutants:
 - Carbon Black
 - HFC
 - Methane
- A partnership of governments, NGOs & Industry
 - 49 countries
 - 53 industry and NGO partners
- The Coalition is government-led but is highly cooperative and voluntary.



- **A Secretariat is hosted by the United Nations Environment Programme (UNEP).**
- **A Working Group**, with representatives from the partners, oversees the cooperative actions of the Coalition.
- **A High-Level Assembly** of the Coalition partners convenes to set policy, take stock of progress and initiate future efforts.
- **A Scientific Advisory Panel** is responsible for keeping the Coalition abreast of new science development on short-lived climate pollutants, answer specific questions of the Coalition and inform policy discussions.



Both sides of the HVACR industry are fully represented:

HFOs vs. Natural Refrigerants

Both sides are calling for the industry to transition to Low GWP refrigerants using the Montreal Protocol

III. Montreal Protocol

Open Ended Working Group April 2015

[Presentations and Discussion](#)

- European Union
- North America
- India
- China
- Africa
- Micronesia

Countries That Support HFC Phase Down



Source IGSD HFC Primer Nov 2013

III. Montreal Protocol

Open Ended Working Group April 2015

[Presentations and Discussion](#)

- European Union
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- Africa
- Micronesia

You can access extensive reporting

The bottom line is agreement in principle to the phase down of HFC

The future of refrigerants is clear:
HFOs vs. Natural Refrigerants

Emissions reduction by policy / action: Economist

Policy/Action	emissions	Period	emissions*
Montreal protocol ¹	135.0bn	1989-2013	5.6bn
Hydropower worldwide ²	2.8bn	2010	2.8bn
Nuclear power worldwide ²	2.2bn	2010	2.2bn
China one-child policy ³	1.3bn	2005	1.3bn
Other renewables worldwide ²	600m	2010	600m
US vehicle emissions & fuel economy standards ^{†4}	6.0bn	2012-25	460m
Brazil forest preservation ⁵	3.2bn	2005-13	400m
India land-use change ⁶	177m	2007	177m
Clean Development Mechanism ⁷	1.5bn	2004-14	150m
US building & appliances codes ⁴	3.0bn	2008-30	136m
China SOE efficiency targets ⁸	1.9bn	2005-20	126m
Collapse of USSR ⁹	709m	1992-98	118m
Global Environment Facility ¹⁰	2.3bn	1991-2014	100m
EU energy efficiency ¹¹	230m	2008-12	58m
US vehicle emissions & fuel economy standards ^{†4}	270m	2014-18	54m
EU renewables ¹¹	117m	2008-12	29m
US building codes (2013) ¹²	230m	2014-30	10m
US appliances (2013) ¹²	158m	2014-30	10m
Clean technology fund ¹³	1.7bn	project lifetime	na

CATEGORIES:

Energy production
 Transport
 Other regulations
 Global treaties
 Land & forests

III. Refrigerant Regulations Are Changing Rapidly & Fundamentally

- The EU legislation: phase down High GWP HFC use by 2030.
- G20, Climate and Clean Air Coalition: same by 2035
- Montreal Protocol highly likely to adopt HFC phase down.
- Australia is committed to High GWP HFC phase down.
- OEMs are shifting to Natural and HFO refrigerants **now**.

III. A Global Industry

Refrigerant regulations and international agreements matter because:

- High GWP refrigerants will become **19%** of global emissions by 2050 unless phased down / out*.....and potentially a great deal more!
- Low GWP refrigerant alternatives are available / proven.
- **New refrigerants require new plant, significant retrofit.**
- **All Low GWP refrigerants are flammable > new requirements.**
- Natural Refrigerants, HFOs require new regulatory systems – licensing, training, innovation and validation by sector.

*Source: Dr. Gus Velders et al, 24 FEBRUARY 922 2012 VOL 335 SCIENCE

III. A Global Industry

Refrigerant regulations matter because:

- High GWP refrigerants will become 20% of global emissions by 2050 unless phased out.
- Low GWP refrigerant alternatives are available / proven
- New refrigerants require new plant, significant retrofit.

Refrigerants are a key determinant of HVACR energy efficiency:

Natural Refrigerants are far more energy efficient.

HFOs are low GWP, but not more energy efficiency.

III. Refrigerant Regulations Are Changing Rapidly

- The EU legislation: phase down High GWP HFC use by 2030.
- G20, Climate and Clean Air Coalition: same
- Montreal Protocol highly likely to adopt HFC phase down
- OEMs are shifting to Natural and HFO refrigerants now

Implication:

From a procurement POV 2030 is **NOW** – to avoid redundancy & capitalize on the efficiency of Natural Refrigerants

III. Refrigerant Regulations Are Changing Rapidly

Implication: From a procurement POV 2030 is **NOW**:

The Australian HVACR industry has the opportunity to:

- **Reduce the energy cost of HVACR by 70%+ (\$10B PA)**
- **Reduce GHG emissions by 50% +**
- **Reduce national emissions by 7% from HVACR alone**

III. Refrigerant Regulations Are Changing Rapidly

Implication: From a procurement POV 2030 is **NOW:**

The Australian HVACR industry has the opportunity to:

Reduce the energy cost of HVACR by 60%+ (\$8B PA)

Reduce GHG emissions by 50%

Reduce national emissions by 7% from HVACR alone

These opportunities are commercially warranted!

III. Refrigerant Regulations Are Changing Rapidly

Implication: From a procurement POV 2030 is **NOW**:

Despite the major benefits of transition to low emissions technology the HVACR industry will be highly controversial for the foreseeable future.

You can expect a good deal of obfuscation as the various commercial interests press their POV.

III. The Consumer Goods Forum

Over 400 multinational food retailers and suppliers:

- Sainsbury, Tesco, Carrefour, Woolworths, Metcash etc.
- Unilever, Nestles, Kraft, Coca Cola, Red Bull, etc.

Member revenue per annum over \$3.5 Trillion

Comprehensive Sustainability Strategy:

- *Transition to natural refrigerant based technology by 2015*
- *All HVACR applications*
- <http://www.theconsumergoodsforum.com/strategic-focus/sustainability/our-sustainability-pillar>

IV. HVACR in Australia

It is not clear to us that the energy management industry is sufficiently engaged with HVACR energy efficiency!

- Specifiers
- Contractors
- Owners & Users

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- Specifiers
- Contractors
- Owners & Users

We believe the industry can reduce energy consumption by 60/70% - \$8/10 B PA

IV. Transition to High Efficiency, Low Emissions

**HOW to
generate
high ROI ?**

IV. Transition to High Efficiency, Low Emissions

Opportunities for HVACR Energy Efficiency:

➤ **Technology:**

- New more energy efficient solutions
- Integration for optimal cost savings, emissions reduction

➤ **Management**

- Life Cycle Costing
- Life Cycle Management

➤ **Collaboration**

- Government & Industry
- Training & Education

IV. High Efficiency, Low Emissions Technology

Vapour Compression by sector

- High Rise HVAC, Industrial HVAC
- Commercial and Residential Split System HVAC
- Cold Stores & Cool Rooms
- Commercial Refrigeration
- Industrial Refrigeration
- Transport Refrigeration
- District Energy

Integrated Energy Efficiency

Energy

- Measurement
- Control Systems
- Voltage Optimisation
- Power Factor Correction
- Maintenance

Heat Load Management

Windows,
Ambient temperature air ingress, egress
Ducting / Insulation
Low Heat Lighting
Fans
Reflective Paint, Roof Heat Management

IV. Integrated Energy Efficiency Engineering

Vapour Compression by sector

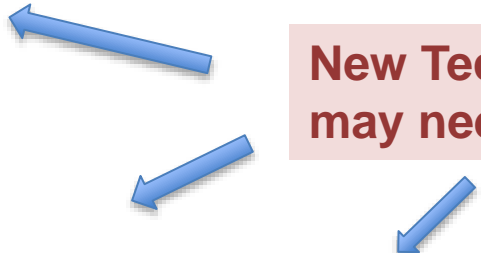
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- Commercial and Residential Split System HVAC
- Cold Stores & Cool Rooms
- Commercial Refrigeration
- Industrial Refrigeration
- Transport Refrigeration
- District Energy

Energy Management

- Measurement
- Control Systems
- Power Factor Correction
- Voltage Optimization
- Maintenance

Heat Load Management

Windows, Ducting
Ambient temperature air ingress, egress
Low Heat Lighting
Reflective Roof
Roof Heat Management / Insulation
Fans



New Technology You
may need to consider

IV. Transition to High Efficiency, Low Emissions

There are enormous opportunities for HVACR energy efficiency and significant barriers:

Opportunity: Integrated HVACR Energy Efficiency Solutions

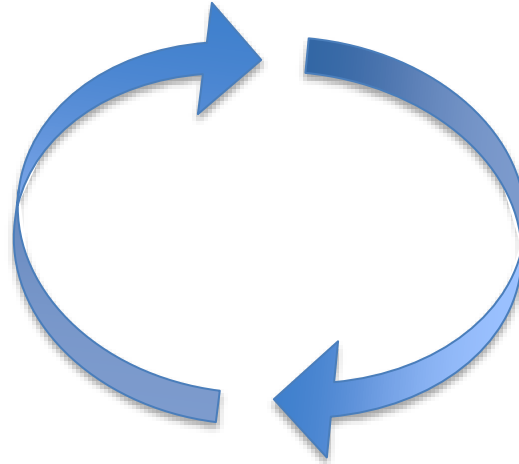
- Measurement
- Selection
- Design
- Integration
- Commissioning
- Operation
- Maintenance
- End of Life Management

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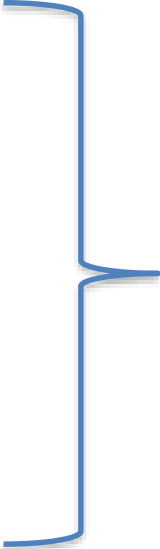
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IV. Transition to Integrated Energy Efficiency

Opportunity: Integrated HVACR Energy Efficiency Solutions

- Measurement
- Selection
- Design
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- Commissioning
- Operation
- Maintenance
- End of Life Management




Through life management is
fundamental to energy
efficiency

IV. Transition to Integrated Energy Efficiency

Opportunity: Integrated HVACR Energy Efficiency Solutions

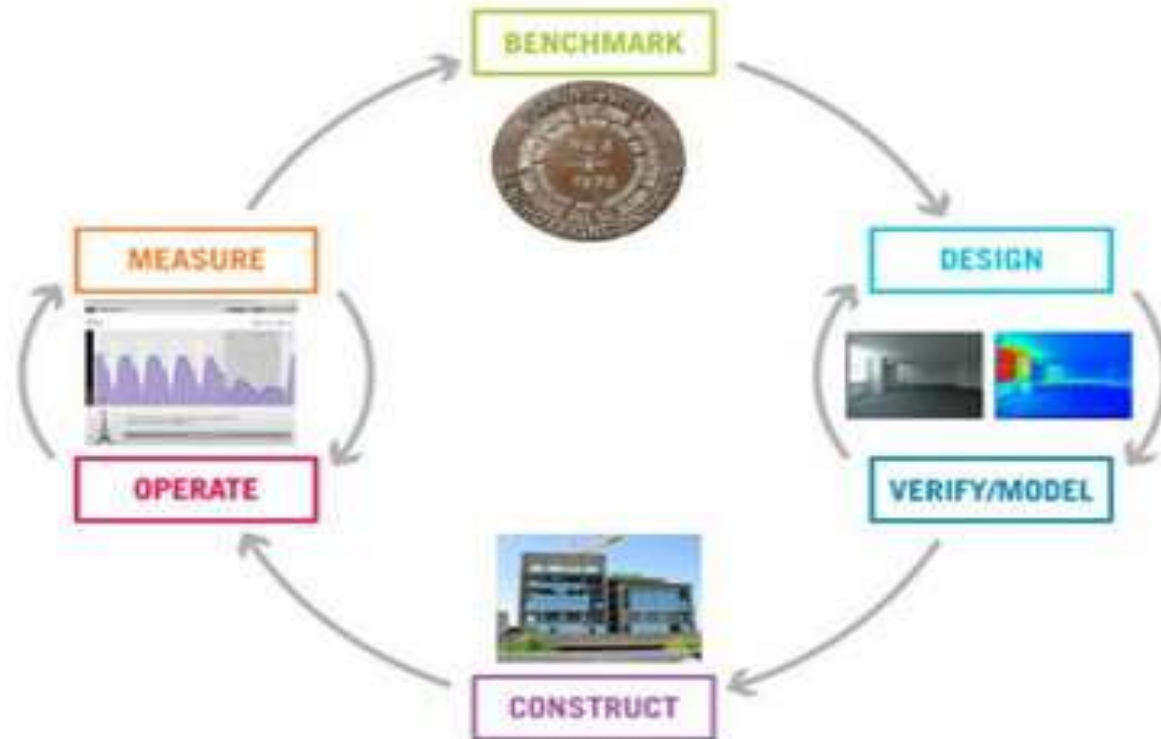
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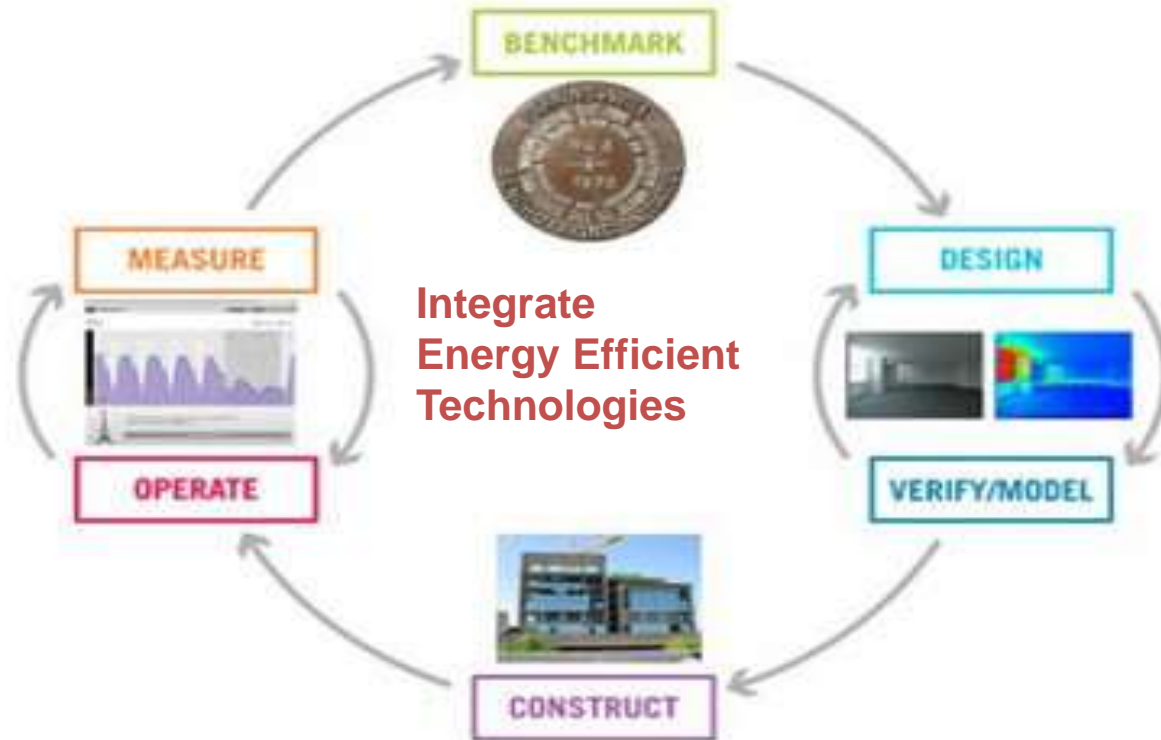
The energy and cost savings
could be as much as \$10 B PA

Life Cycle Costing is fundamental

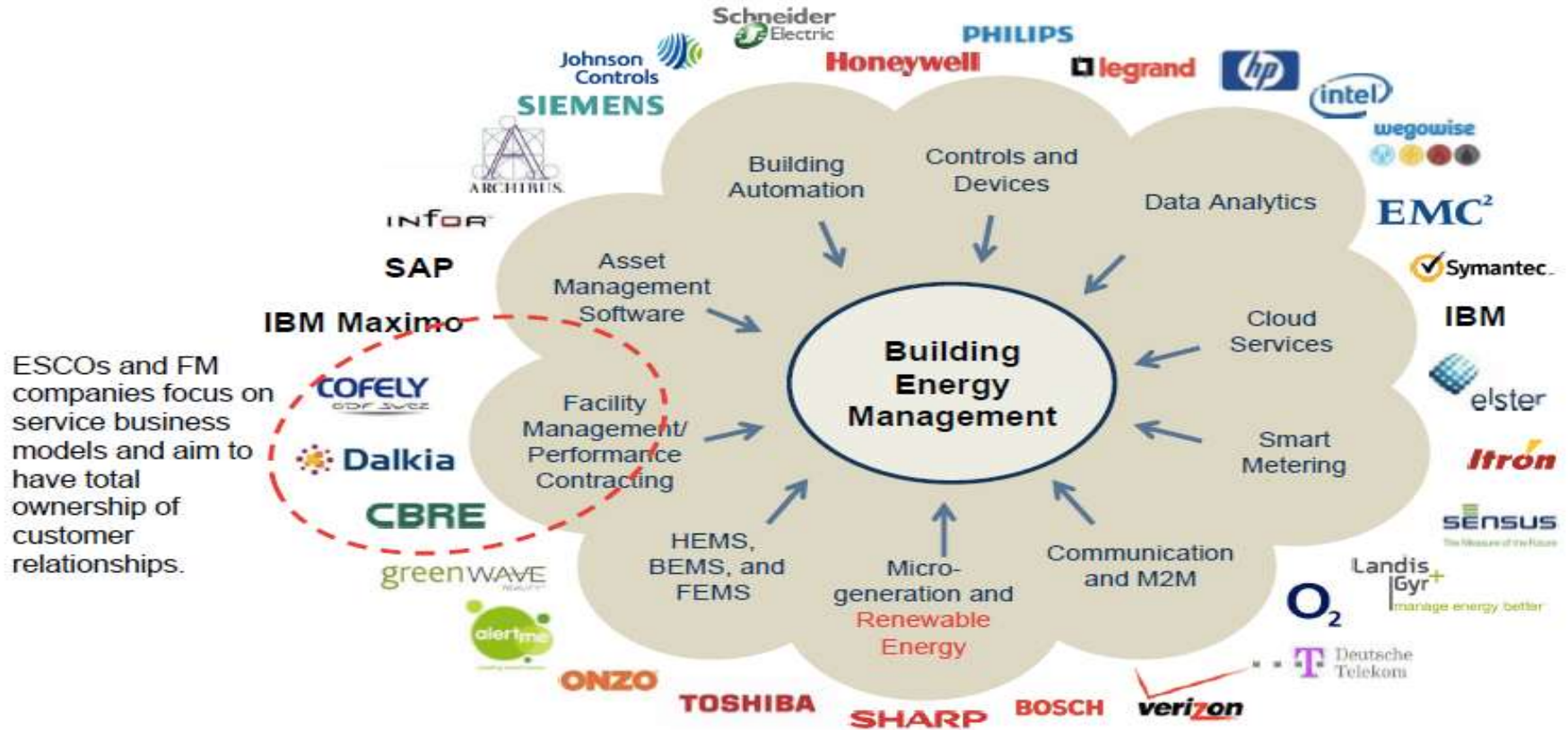
Schneider Survey: Realizing the full potential of your energy efficiency investments through Information Technology /Operating Technology convergence.



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Specifiers have a critical role.....in HVACR???



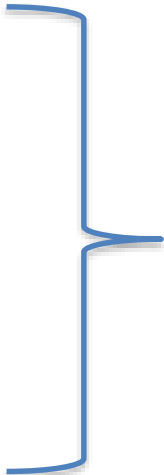
Source: Frost Sullivan – All Energy Conference

V. Transition to Integrated Energy Efficiency

It is critical that specifiers, contractors and end users embrace HVACR energy efficiency via:

Integrated Energy Efficiency Assessment and Management

- Measurement
- Selection
- Design
- Integration
- Commissioning
- Operation
- Maintenance
- End of Life Management



The energy and cost savings
could be as much as \$10 B PA

Life Cycle Costing is fundamental

V. Technology: Vapour Compression

Sector	Indicative volume	Relevance
Split System HVAC - New - Retrofit	1,000,000 PA 12,000,000 installed	Low Rise Commercial & Residential
High Rise HVAC	30,000 / 100,000	Commercial, Industrial
Cold Stores	20,000	Manufacturers, cold chain operators
Cool Rooms	80,000	Retailers, Hospitality
Display Cabinets	1,000,000	Retail
Commercial Refrigeration	10,000	Grocery Stores
Automotive AC	12,000,000	Everyone
Transport Refrigeration	30,000 vehicles	Cold Chain
Hot Water, Heat Pumps	12,000,000	All buildings and facilities
District Energy	Thousands	CBD, Health care, Education, Agri B

V. Technology: Vapour Compression

Sector	Solution	Benefit	Suppliers
Split System HVAC	Hydrocarbon refrigerant 12,000,000	40-60% energy Low capital cost	Pioneer International
High Rise HVAC	Ammonia 100,000	40% energy saving No direct emissions	Scantec TriTech Minus 40 CA Group GEA Refrigeration
High Rise HVAC	Hydrocarbons 100,000	40% energy saving Low direct emissions	Engas Hychill Geoclima
Evaporative Cooling	Air & water refrigerant based HVAC	High efficiency No direct emissions	Seeley International

V. Technology: Vapour Compression

Sector	Solution	Benefit	Suppliers
Cold Stores	Ammonia 20,000	40% energy saving	Scantec GEA Refrigeration
Cool Rooms	Hydrocarbons 80,000	40% energy saving	Engas GEA Refrigeration
Commercial Refrigeration	Transcritical CO2 Ammonia / CO2 10,000 grocery stores	High energy savings	Minus 40 TriTech NSW Scantec CA Group Geoclima GEA Refrigeration
Display Cabinets	Hydrocarbon, CO2	40% energy saving	Cyberchill ICS Pacific
Transport	30,000 vehicles + Reefers	Fuel efficiency 40% energy savings	Hychill Carrier - NaturaLine CO2
Heating	Boiler Controls	10/20% energy saving	CCM Energy Solutions
District Energy	Decentralised energy, heating, cooling	Major cost and emissions reduction	ComfortiD Alfa Laval

V. Technology: Heat Load Mgmt

Sector / Energy Savings	Relevance	Suppliers
Energy Management +20%	Measurement & Reporting “its all about the data”	WattWatchers Envizi
Reflective Paint + 20/40%	Heat Reflection, large roofs	Sky Cool
Roof Heat Manage’t + 20/30%	Heat use and evacuation	Smart Breeze
Maintenance + 20/30%	Coil & filter cleaning	Aeris Environmental HydroKleen
Control Systems + 20/40%	Optimise energy use & performance Remote Reporting & Manage	Aeris Environmental Wavetronics
Fire Mitigation	Oxygen Reduced Plant Rooms Refrigerant Leak Detection	Fire Pass, ACES Wavetronics
Fans +20%	Energy Efficiency	Aeratron
Windows + 20/40%	Reflective Blinds and Tints Retrofit Double Glazing	Inflector Hanita Pacific EcoMaster
Low Heating Lighting +10/20%	LED efficiency	Lots – find one that understands heat load?

V. Technology: Integrated Energy Efficiency

Sector	Relevance	Suppliers
Voltage Optimisation +30%	Energy management	Power Star
Power Factor Correction +30%	Energy management	AMP Control

VI. Indicated actions

Management

Too often we are told that capital cost is the key determinant of buying decisions in association with:

- A lack of financing initiative
- Split incentives
- Lack of Life Cycle Costing, and Life Cycle Management

VI. Indicated actions

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We see enormous opportunity for HVACR cost reduction and performance improvement through better management of the full range of considerations

VI. Indicated actions

Management

Too often we are told that capital cost is the key determinant of buying decisions in association with:

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We see enormous opportunity for HVACR cost reduction and performance improvement through better management of the full range of considerations.

The starting point is awareness of the sources of energy efficiency

The next step is understanding and integration!

VI. Indicated actions

Collaboration

- Government & Industry
- Training & Education

The transition to low GWP refrigerants calls for new HVACR industry management systems:

- Standards
- Regulation
- Licensing
- Innovation
- Training & Education
- Communications

Specifiers and End Users should engage with: **ARA, PRIME, DoE, OEH, VEET**

**You need a voice, we need your voice
in these policy developments**

VI. Indicated actions

Collaboration

The transition to low GWP refrigerants calls for new HVACR industry management systems:

Licensing

Low GWP refrigerant based technology is clearly the future but not addressed by the current HVACR licensing system.

Training, Education and Communications

There is an enormous educational need to make all stakeholders aware of the benefits and requirements of low GWP refrigerant based technology (perhaps 100,000 individuals).

Innovation

The technology is available, validation & consideration is critical, government and academia have important roles.

HVACR Energy Efficiency Seminar Series



November
2014

Brisbane :: Sydney

Melbourne

Video Presentations available
from B2BForums.com

Presented by
B2B Forums
in association with



ARA

Forging the Future for Refrigeration and Air Conditioning

**Australian
Refrigeration
Association**

HVACR Energy Efficiency Seminar Series



Partners



Tell Me What You Need !

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