



Tomorrow's World in Refrigeration and Air Conditioning

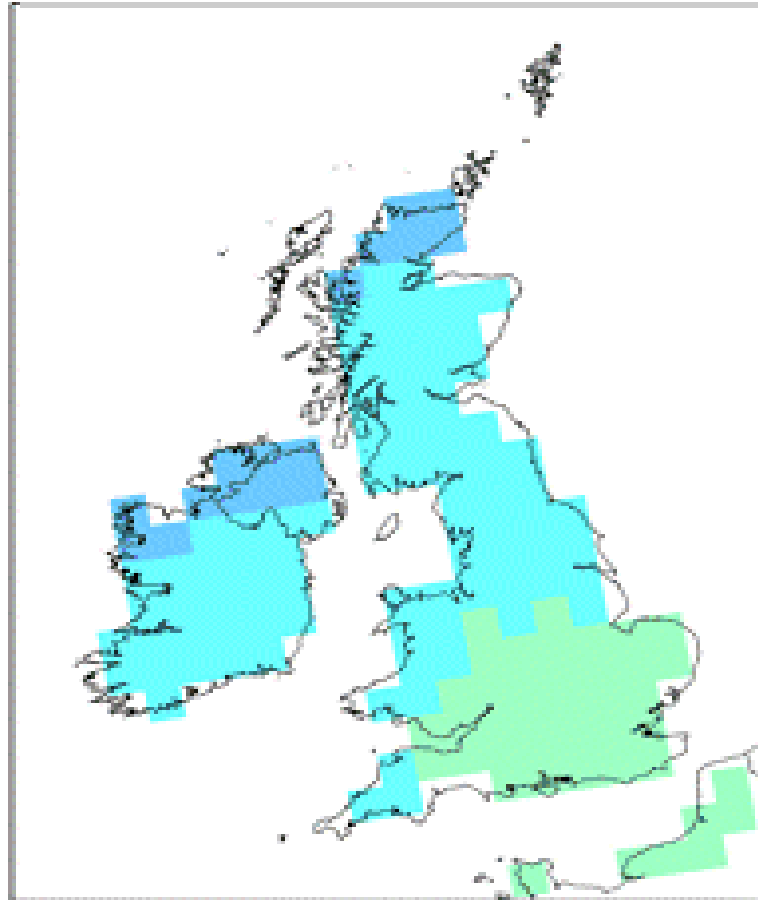
Graeme Maidment



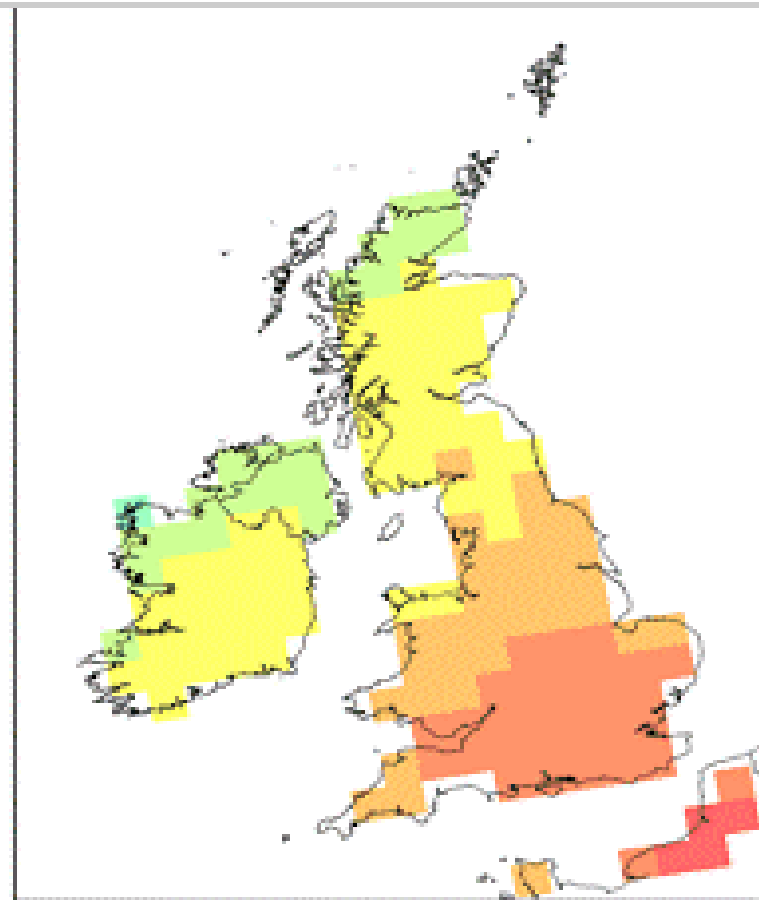
Content

- The key driver
- Some technological response – a snap shot of research

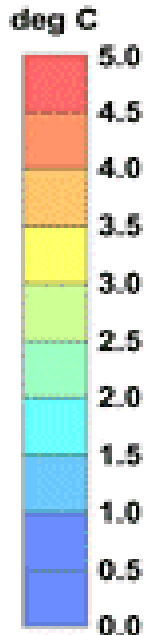
Change in annual average daily temperature – 2080



Low Emissions scenario



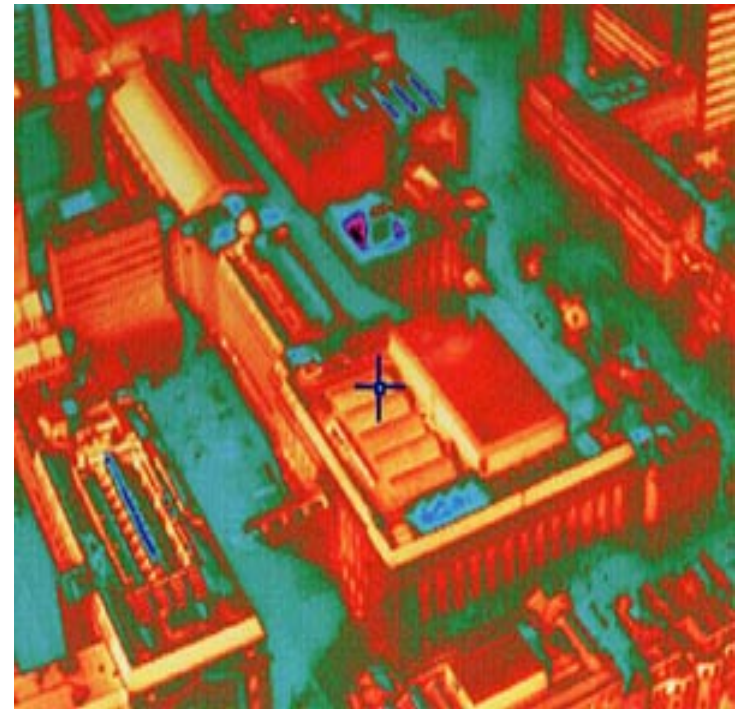
High Emissions scenario



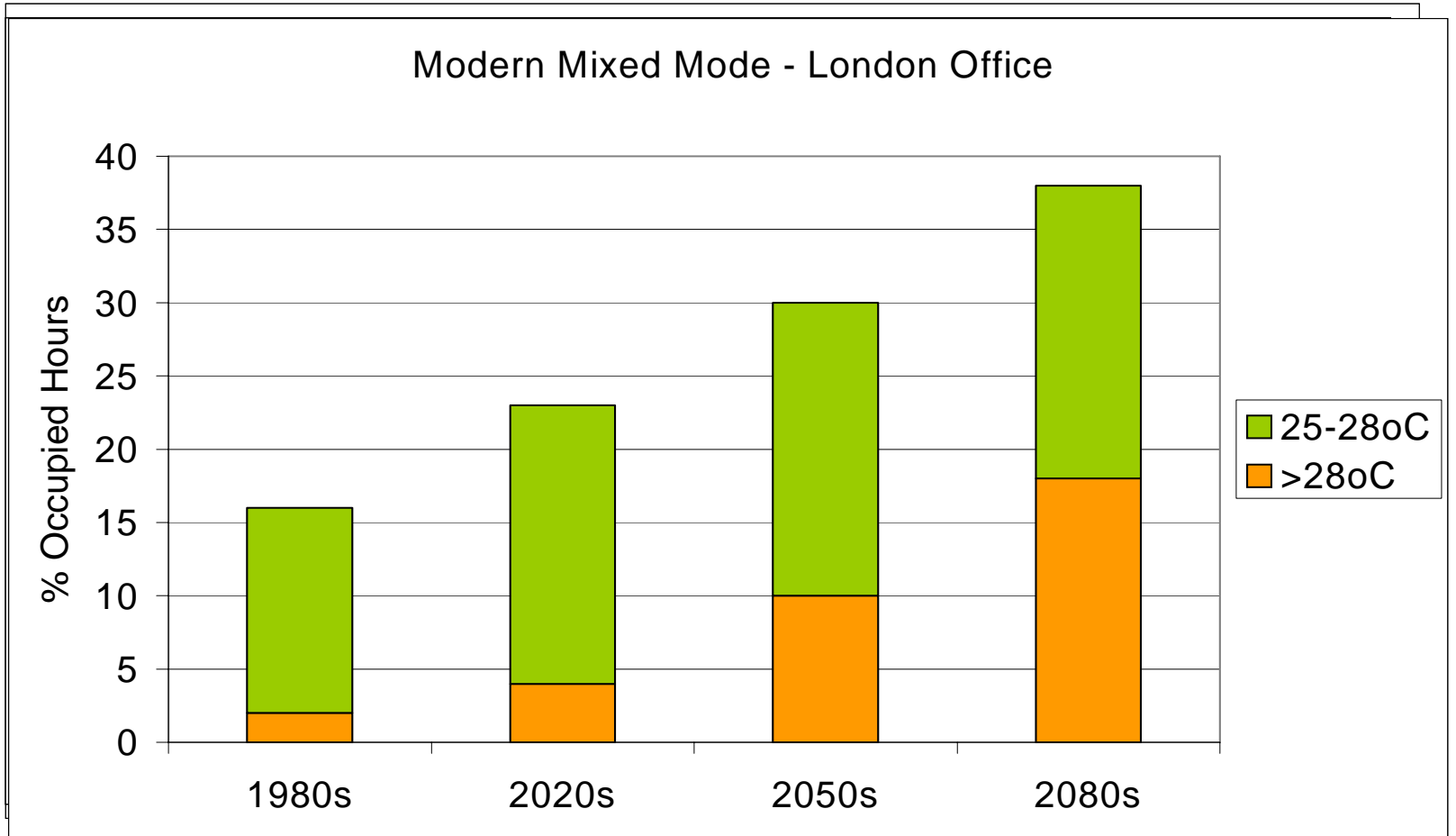
So how will UK buildings perform?

By 2020, 75 per cent of the world's population will live in towns and cities.

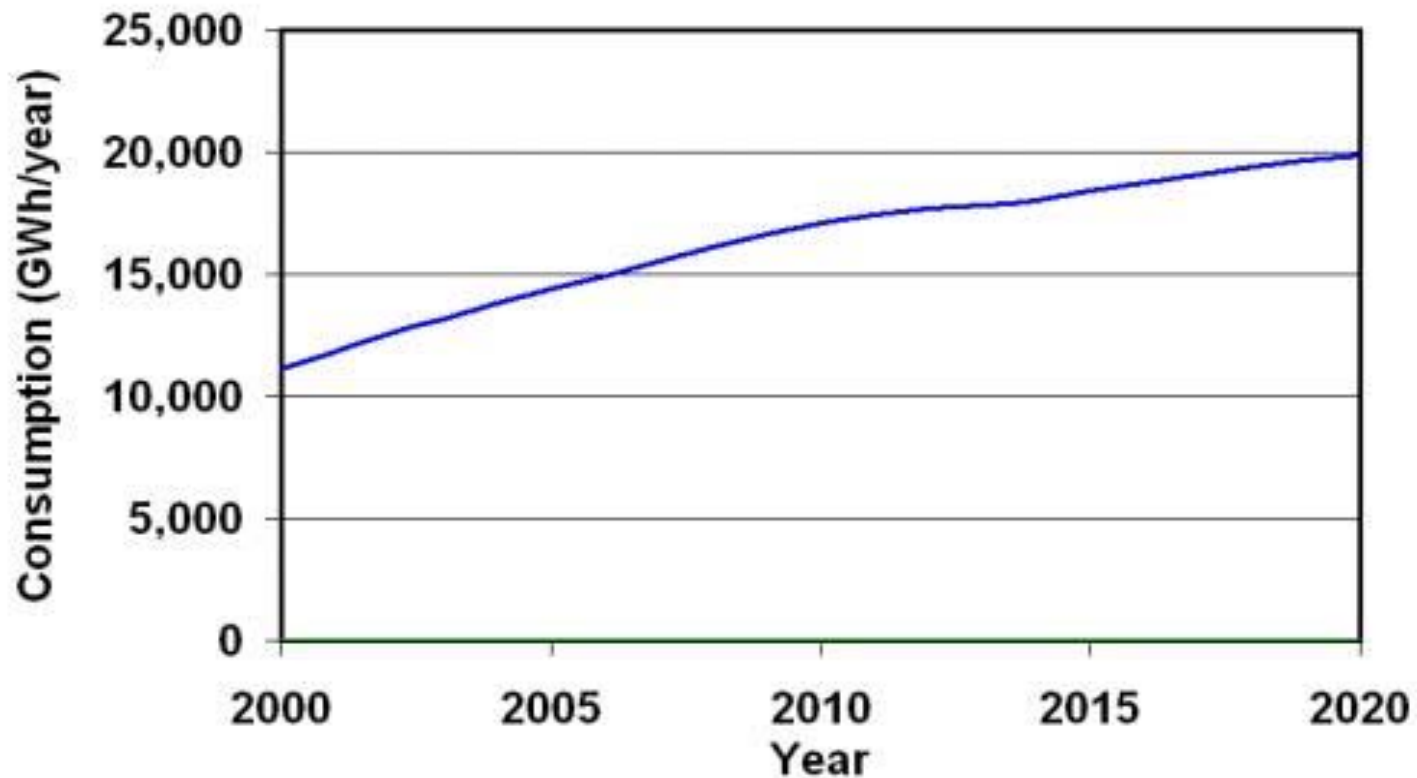
New buildings may have a lifetime of over 100 years.



Predictions in building performance

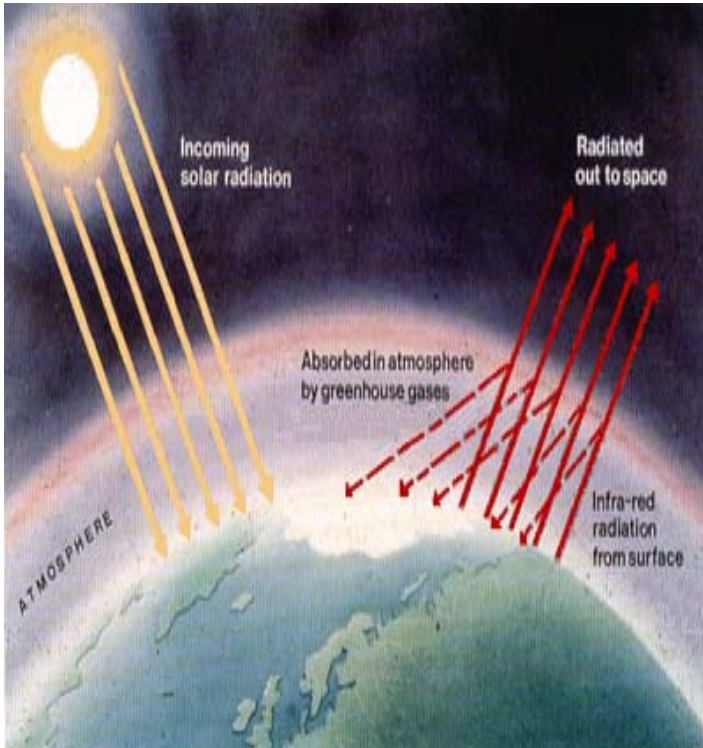


Predicted Growth in A/C Energy Use



Source <http://www.mtprog.co.uk/>

RAC Impact on environment



- UK RAC uses 15% of UK electricity and growing
- Refrigeration produces 10% of total radiative force (IIR, 1992)
 - 20% direct; 80% indirect (IIR, 2007)
- How will this change after R22 phase out?

Legislation

COMMISSION OF THE EUROPEAN COMMUNITIES

....**Towards a comprehensive climate change agreement in Copenhagen**

Brussels, 28.1.2009

- EU objective to ensure that global temperature does not increase more than 2°C above pre-industrial levels.
- developed countries as a group should reduce their emissions.

COMMUNICATION FROM THE COMMISSION

TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN

ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

- 30% below 1990 levels by 2020.
 - 50% below 1990 levels by 2050.
- Towards a comprehensive climate change agreement in Copenhagen
- The UK has set a limit of 80% reduction by 2050

{SEC(2009) 101}

{SEC(2009) 102}

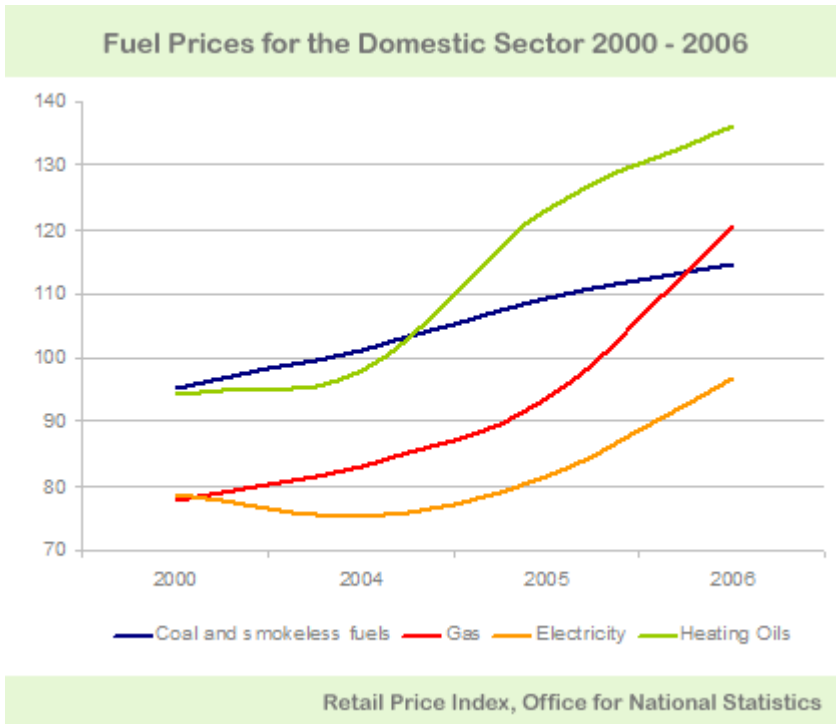
..the Copenhagen agreement also addresses fluorinated gases.....

It states...

- The accelerated phase-out of HCFCs over the coming decade under the Montreal Protocol may lead to a rapid increase in HFC emissions, many of which are very potent GHGs.
- Part of the Copenhagen agreement should include an international emission reduction arrangement for HFC emissions.
- This will encourage industry to step up intensified research into and development of HFCs with low global warming potential and HFC-free alternatives.

Source http://ec.europa.eu/environment/climat/pdf/future_action/communication.pdf

The cost of energy



The new cold war

The cost of carbon?

- Climate adaptation costs could range between € 23-54 billion per year in 2030.
- A multilateral insurance funding to cover disaster losses in case of climate related natural disasters.
- EU ETS \$29/ tonne in 2005 major users.
- Domestic cap or carbon allowances
<http://www.guardian.co.uk/environment/2009/feb/03/personal-carbon-allowances>

So how are we going to reduce emissions by 80% by 2050?

- Globally, it would be desirable to at least double energy-related RD&D by 2012 and increase it to four times its current level by 2020, with a significant shift in emphasis towards low-carbon technologies, especially renewable energy sources.

Source http://ec.europa.eu/environment/climat/pdf/future_action/communication.pdf

So how can R,D&D help?

- Where is cooling being used?
- How can we minimise the need?
- Is our system operating efficiently?
- New components?
- New systems?
- How can academia help?



Where is cooling being used?

Energy efficiency in food refrigeration

	Chilling	Freezing	Thawing Tempering	Secondary cooling	Chilled Storage	Frozen Storage	Transport	Retail	Catering
Energy used									
Throughput									
Energy change in food									
Efficiency									
Energy that could be saved									



Results so far.....

- **Dairy and meat - most likely targets for energy saving**
- **Retail display - high energy consumption**
- **Transport - high savings potential**
- **Lack of measured data in most sectors with the exception of retail display**



How can we minimise the need?

One way to reduce Ca

Fabric gains walls, windows

Is cooling really necessary????.....



Solar gains

Lighting 10-30 W/m²

VIPs (Vacuum Insulated Panels)

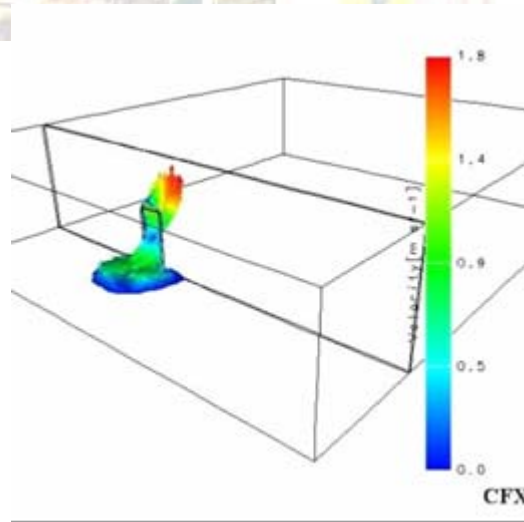
Polyurethane
 0.025W/mK

VIP 0.005W/mK

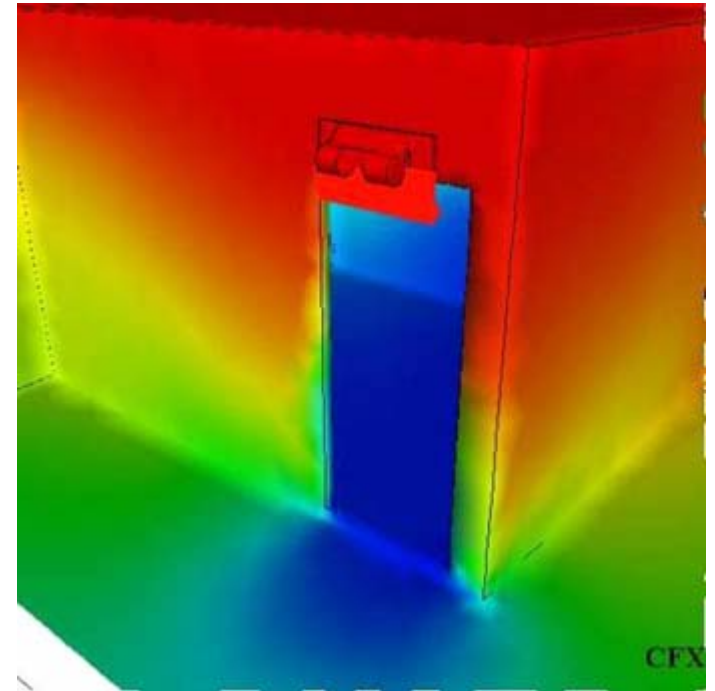
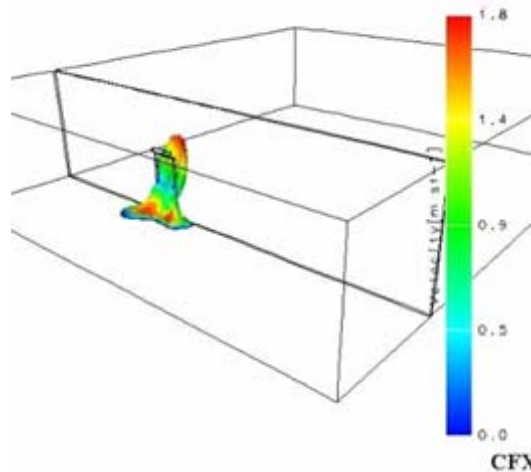


Cold store infiltration

Without air curtain
After 10 s, 2 500 kJ
heat entered store
(dry)



With air curtain
After 10 s, 780 kJ
heat entered store
(dry)
69% reduction



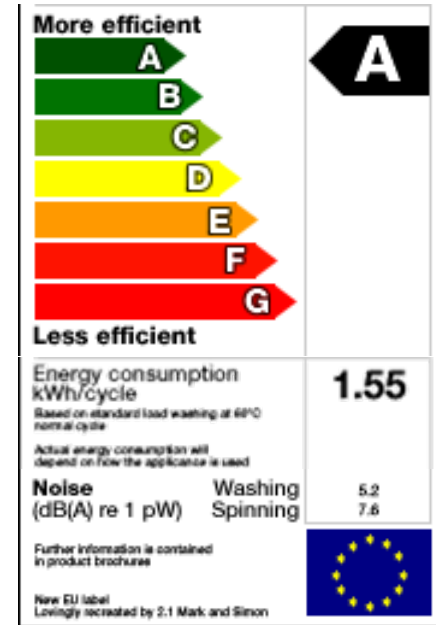


Is our system operating efficiently?

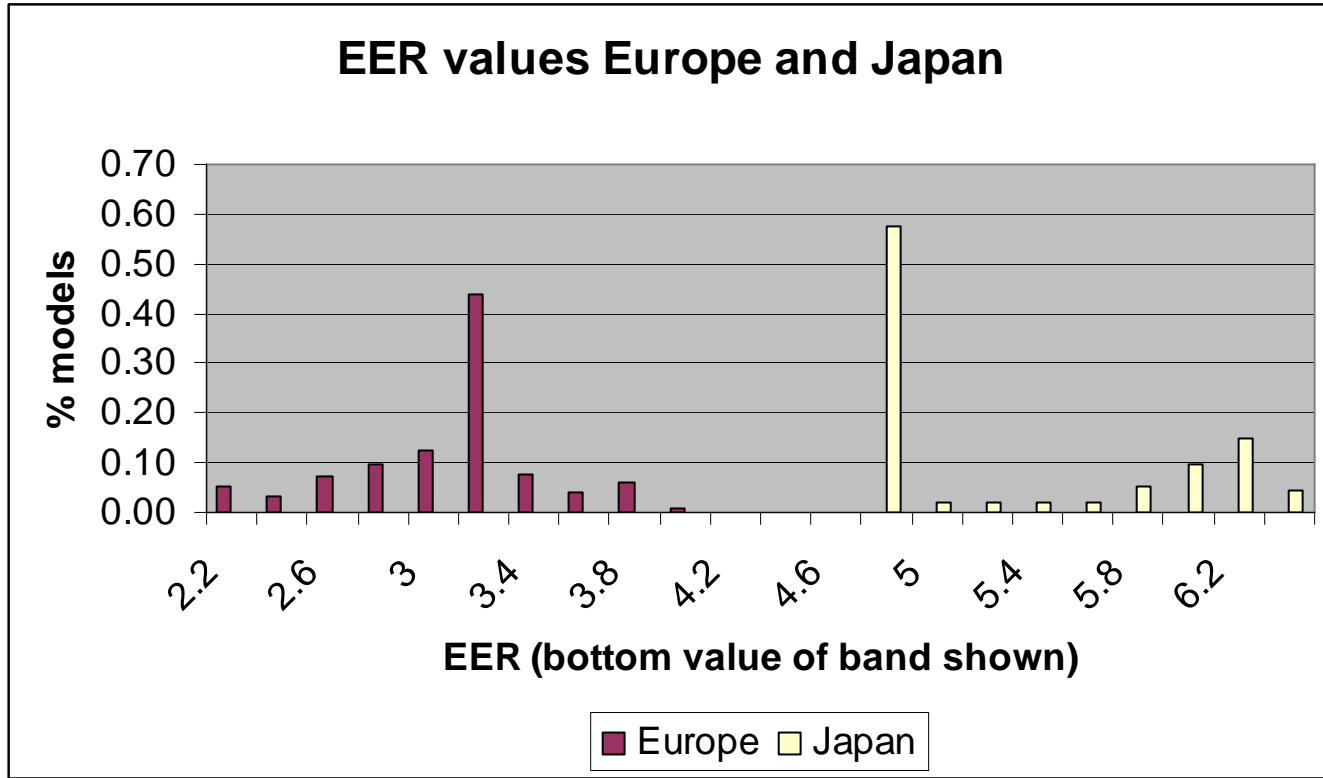


We are used to this....

More efficient design.....



Best Available Technology : Europe versus Japan



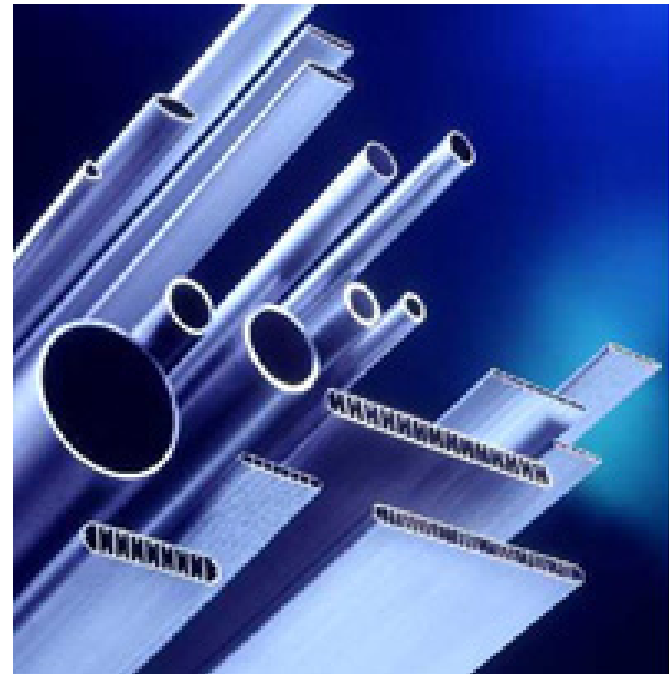
- Japanese market demands high efficiencies
 - typically about twice those in European market
 - but product costs are higher, especially for premium products



New components?

Micro-heat transfer

- 10mm dia tubes, give boiling HTC's c1000W/m²K.
- 1mm dia tubes give 25,000 W/m²K
- Refrigerant volume is much less

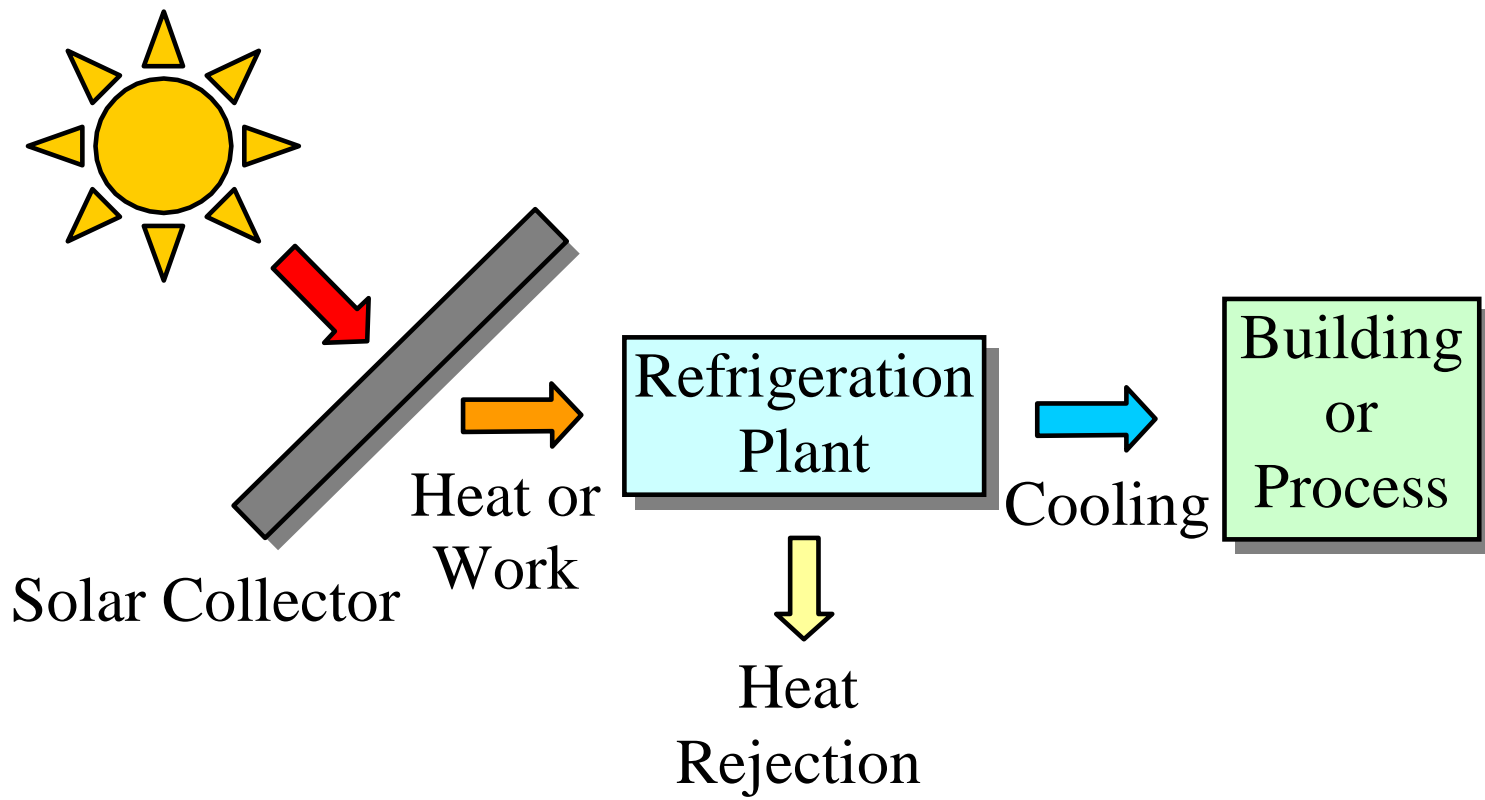




New systems?

Renewable energy powered cooling

Solar Powered cooling



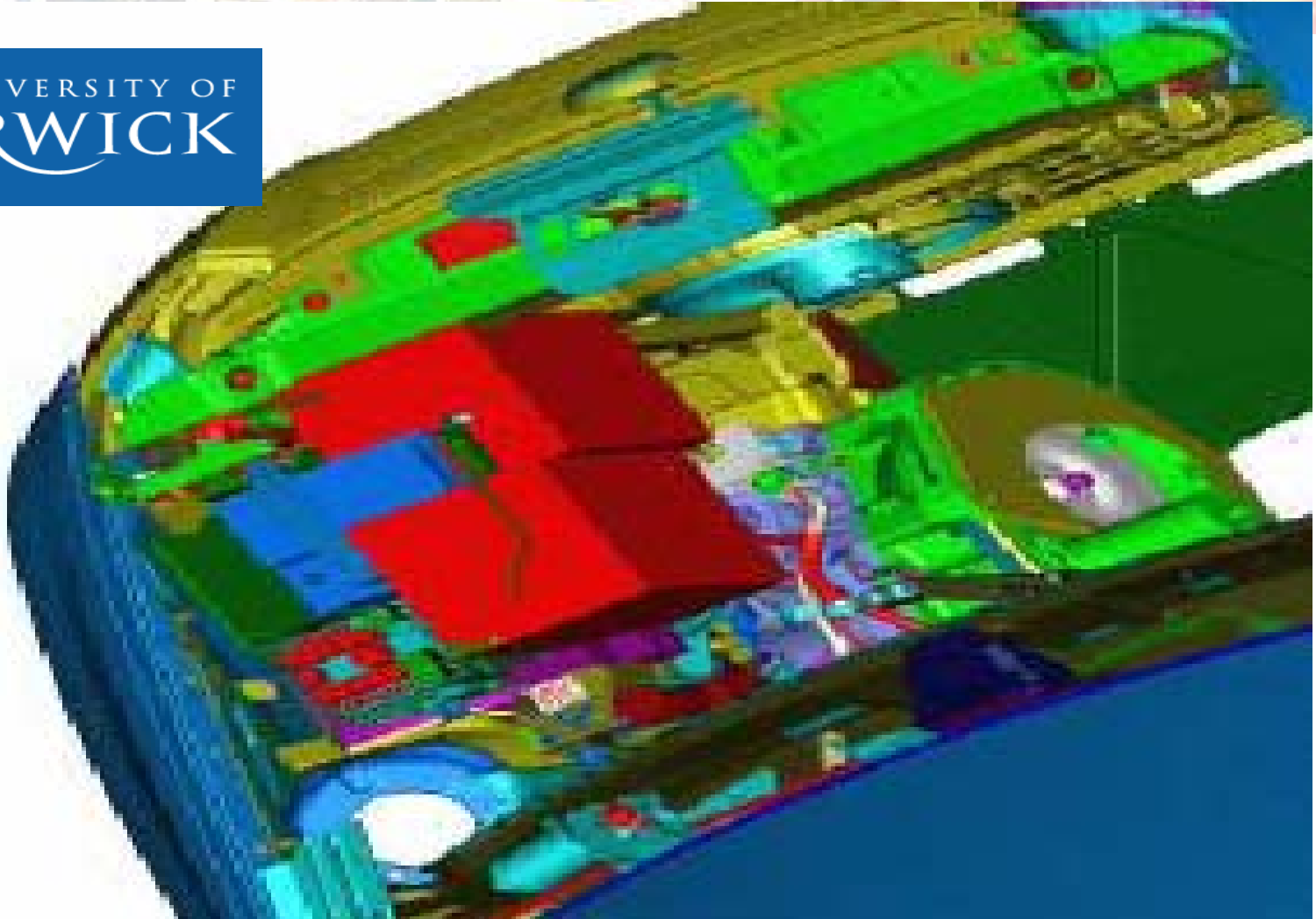


New systems?

Heat powered cooling

The TOPMACS Adsorption system

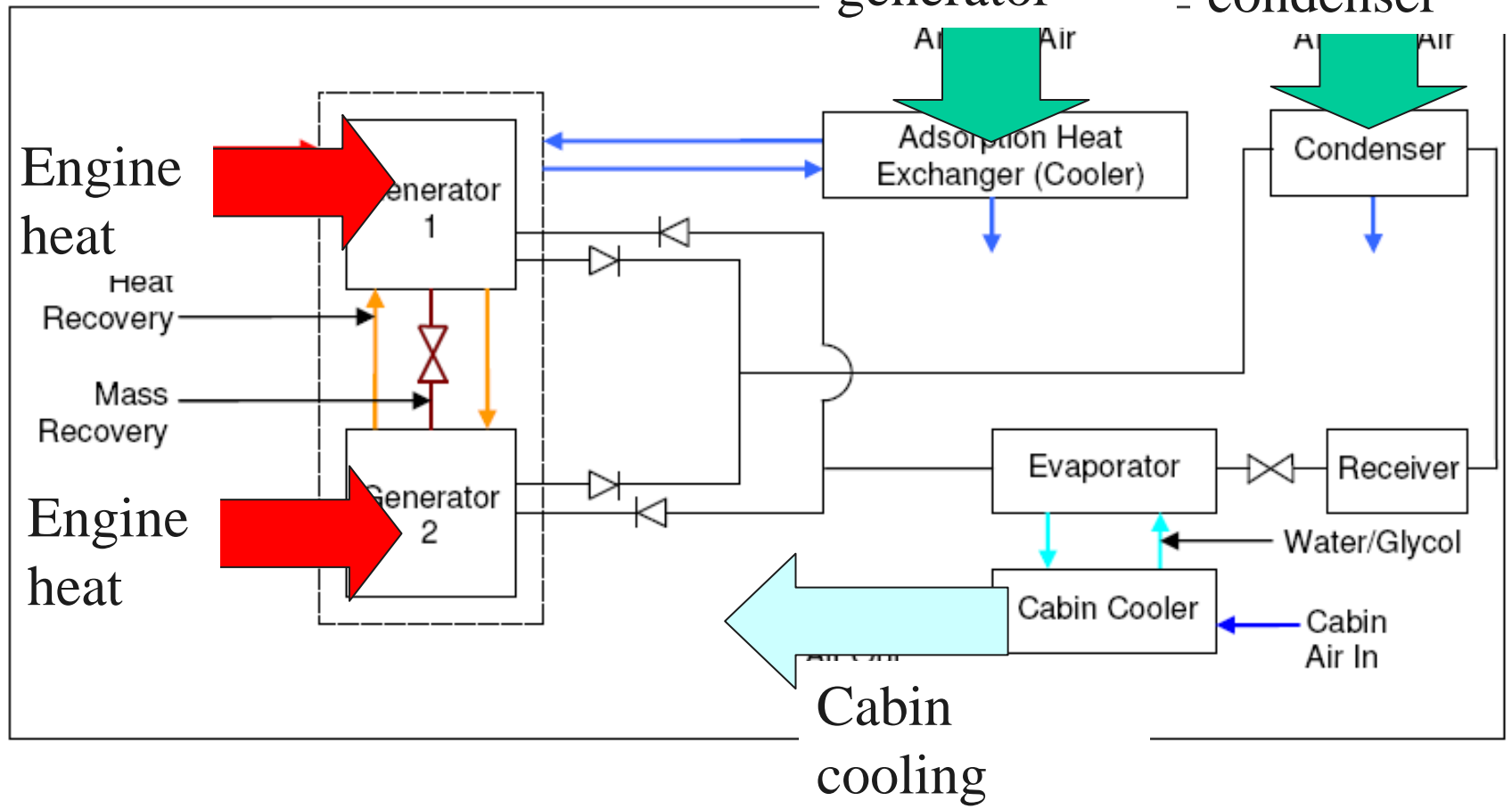
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The TOPMACS Ads

Ambient air cooling the generator

Ambient air cooling the condenser



The TOPMACS Adsorption system

Two applications:

- **C-Class car (2 -3 kW)**
- **Long distance truck**

Type of cycle	CoP _c	Fiat Stilo Cooling Power (kW)	Iveco Cooling Power (kW)
Simple single bed system	0.37	4.99	6.66
Two bed system with mass recovery between beds	0.54	4.95	6.6.

Professor Bob Critoph



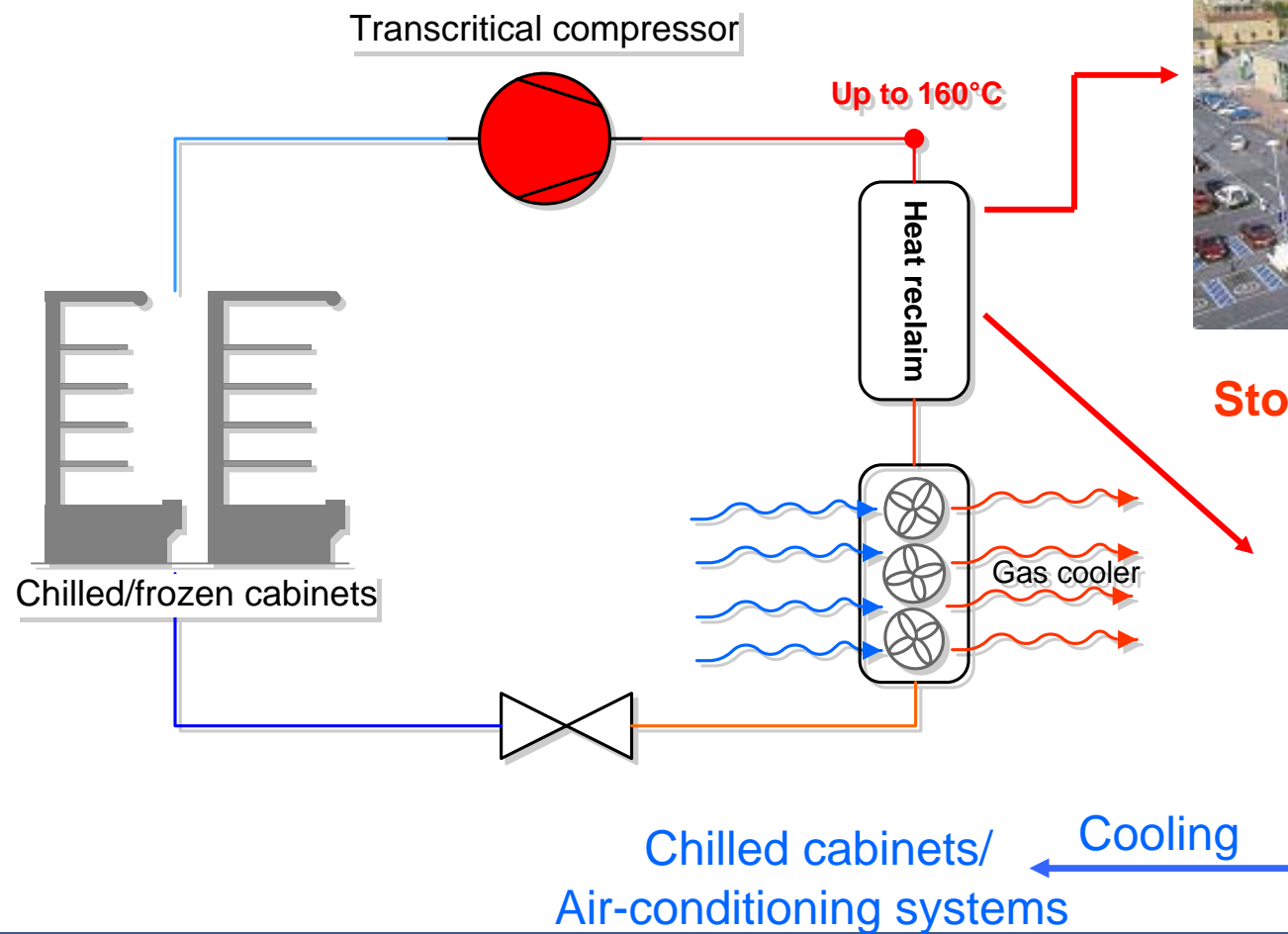
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New systems?

Integrated heating and cooling

Integrated heating and cooling



District heating system



Store HWS / heating system



Absorption chillers



How can Academia help?

- Who is doing what?
 - Ulster, UCL, Bristol, Brunel, Birmingham, Cambridge, City, London South Bank University, Newcastle, Nottingham, Oxford, Warwick.
- Funding opportunities for industrial R&D
- SIRAC Research Network
- www.sirac.org.uk



Conclusions

- Global warming
- Global opportunities
- Next SIRAC meeting 13 May,
University of Warwick
- www.sirac.org.uk



Questions?