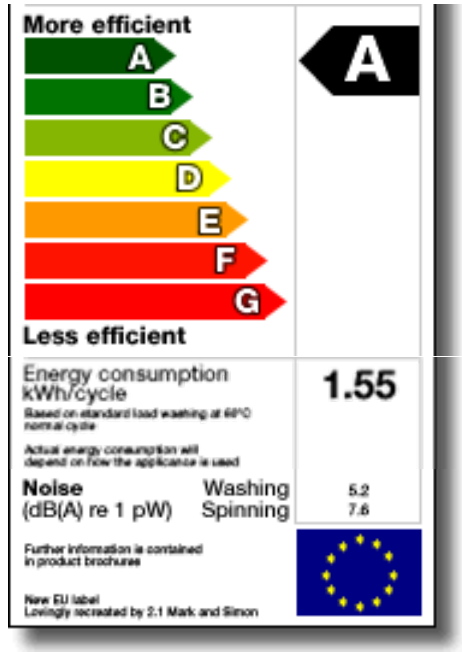
LONDON SOUTH BANK UNIVERSITY

System Efficiency Index for Refrigeration Systems

Graeme Maidment

We are used to this….

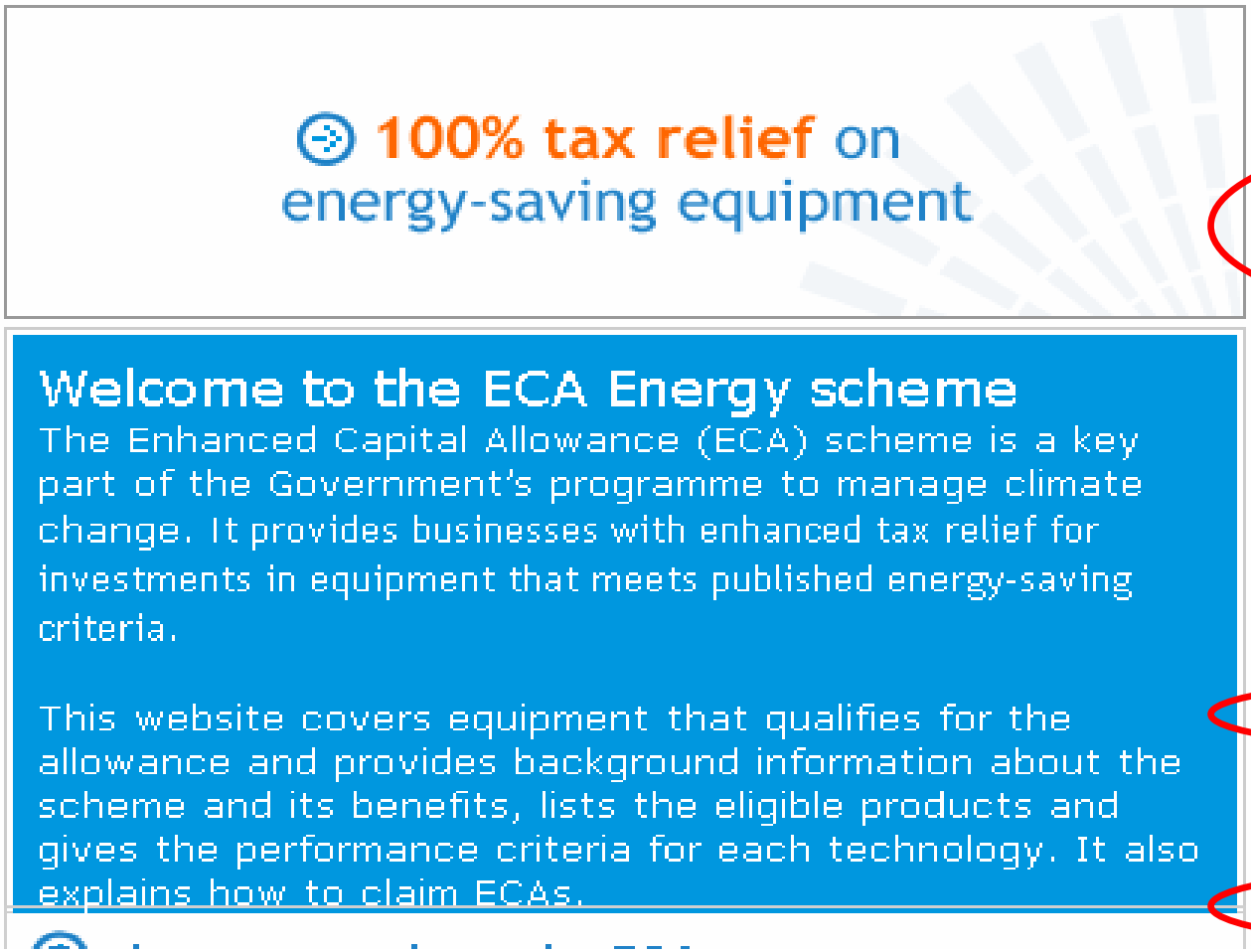
More efficient design……



Why do we need an index?

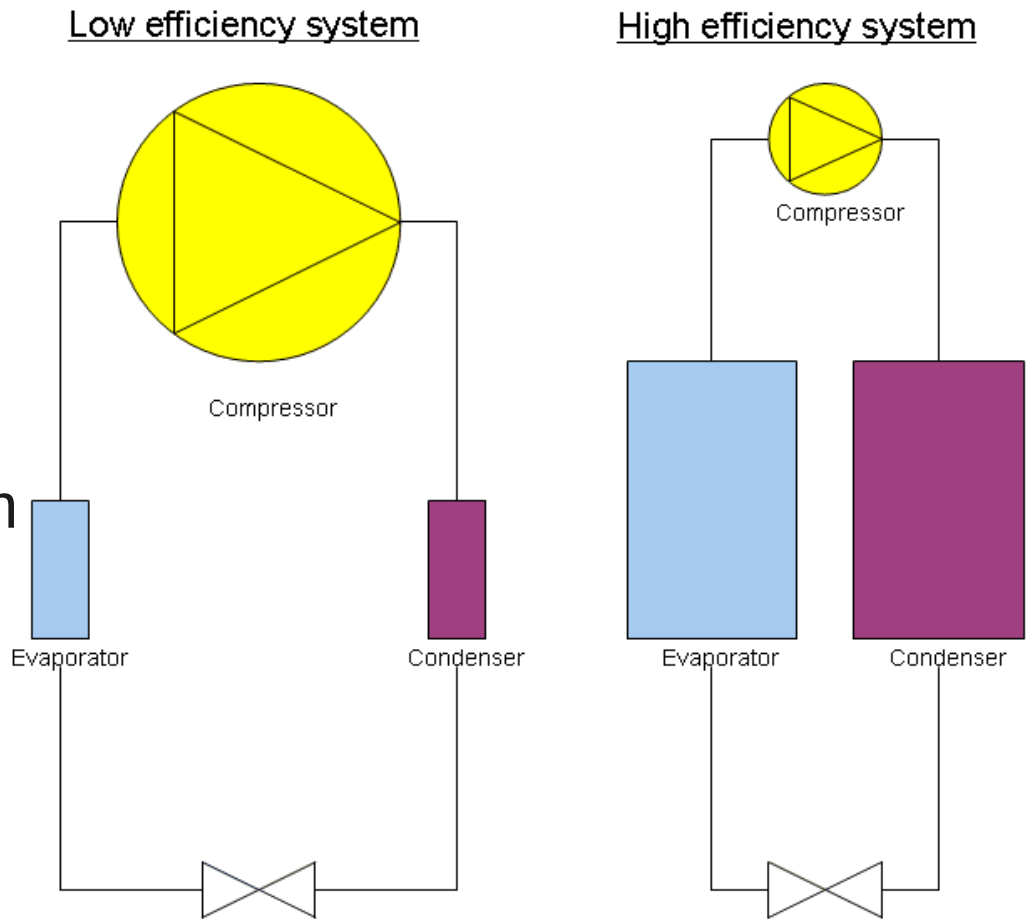
- UK RAC is currently responsible for
  - 5 Million tons of Carbon (2003 levels)
  - 10% of greenhouse emissions
- Variable system performance
  - Sometimes by as much as 50% with similar equipment

The ETL List


100% tax relief on
energy-saving equipment
Welcome to the ECA Energy scheme
The Enhanced Capital Allowance (ECA) scheme is a key part of the Government's programme to manage climate change. It provides businesses with enhanced tax relief for investments in equipment that meets published energy-saving criteria.
This website covers equipment that qualifies for the allowance and provides background information about the scheme and its benefits, lists the eligible products and gives the performance criteria for each technology. It also explains how to claim ECAs.
Published by DEFRA
Search the Energy Technology List
Technology
Refrigeration Equipmer
Sub technology
Please select
Automatic Air Purgers
Cellar Cooling
Commercial Service Cab
Controls
Curtains, Blinds & Cover
Display Cabinets
Evaporative Condensers
Forced Air Pre-Coolers
LPA
Packaged Chillers
Refrigeration Compress

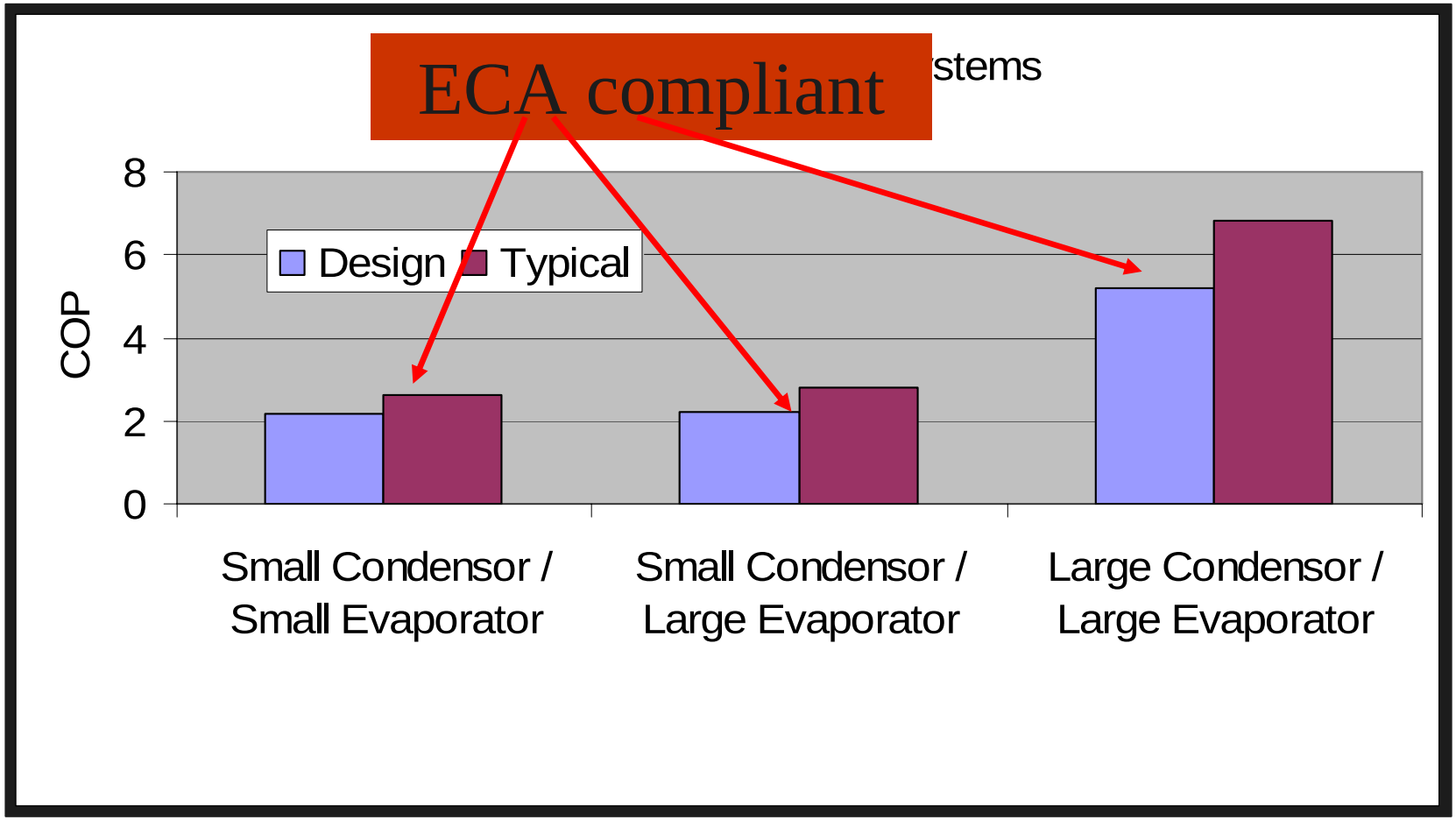
What is wrong with the component Index?

- High compressor efficiency
- Low capital cost
- Low system efficiency
- ECA compliant



- High heat exchanger efficiency
- High capital cost
- High system efficiency

The need for a systems index



The CHP System Index

MANAGED BY CARBON TRUST

ON BEHALF OF defra

HM Revenue & Customs

Combined heat and power scheme (CHP)

A CHP scheme generates heat and power (usually electricity) simultaneously, through a single process.

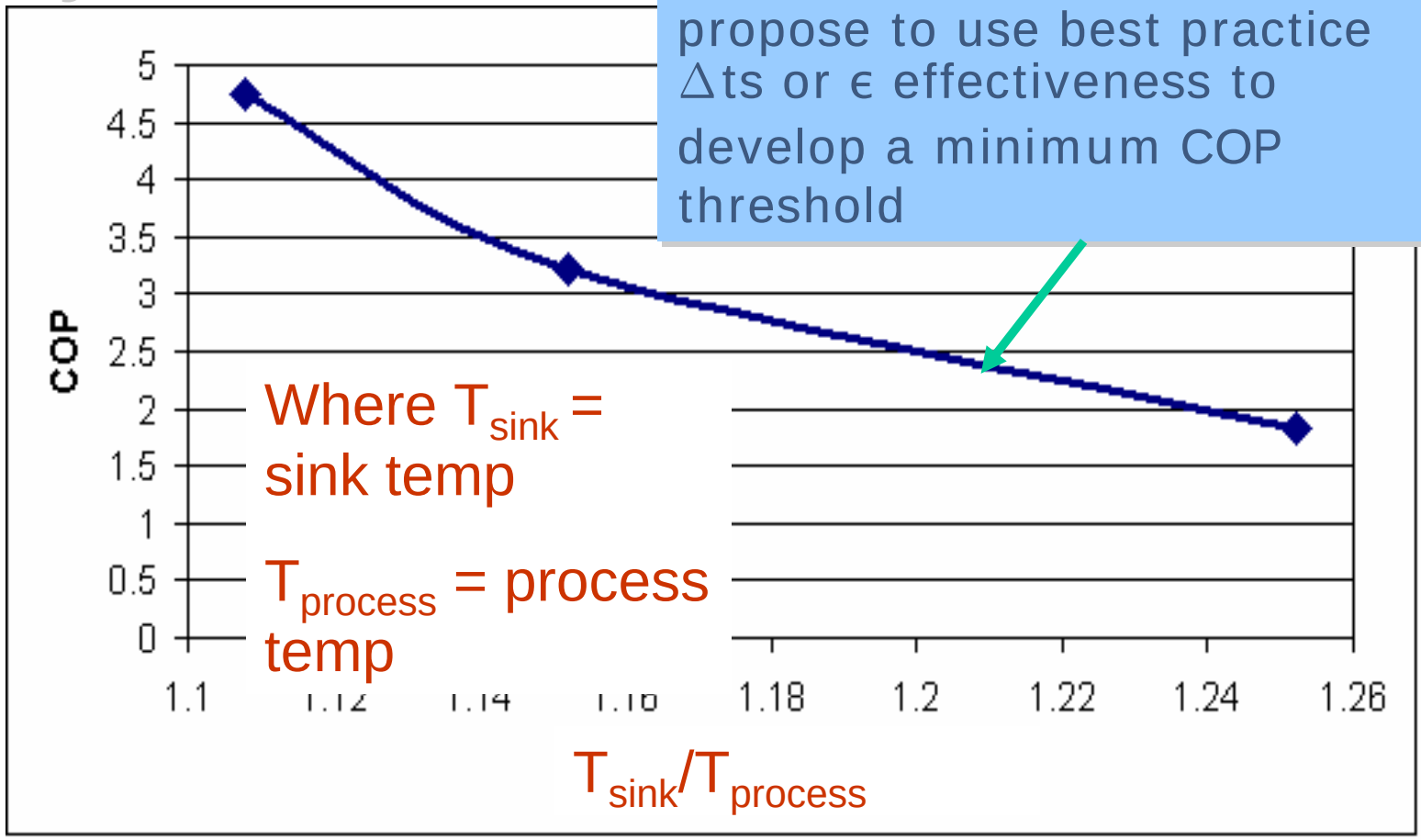
Claiming for an Enhanced Capital Allowance (ECA)
Businesses can only claim an ECA on equipment in this category if they have been granted a Certificate of Energy Efficiency by the Secretary of State.

To qualify for this, a business must first obtain a Combined Heat and Power Quality Assurance (CHPQA) Certificate. These are issued by the CHPQA Programme, not by the Carbon Trust, and must be renewed every year. To find out more about the certificate, and how to apply for one, please refer to the programme's website at www.chpqa.com.

If the certificate is going to be used to claim an ECA, this should be indicated when applying.

A system index.

To represent systems we propose to use best practice Δts or ϵ effectiveness to develop a minimum COP threshold



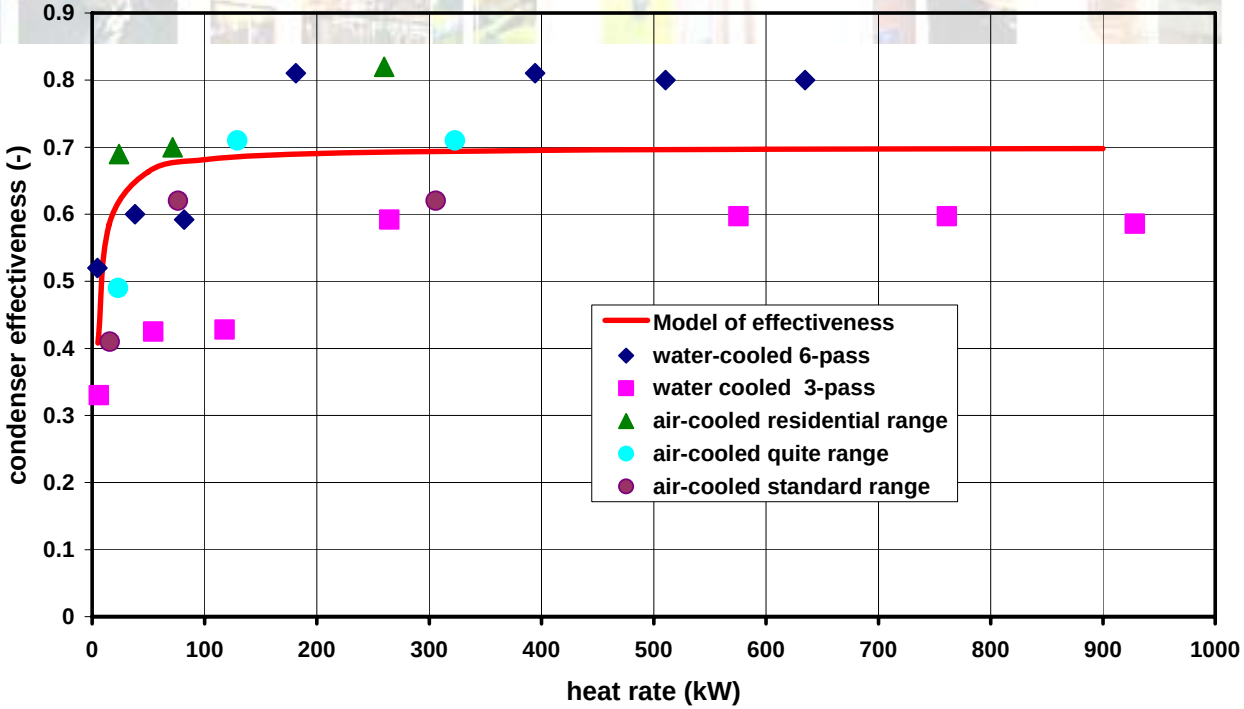
The Challenge

- To develop an index that simulates..
  - multi- temperature systems
  - different condensers
  - Different refrigerants
- To test the index in a range of applications
- To use a web site tool
- To produce a code of practice
- To assess the success

What have we achieved

- Developed the Index
- Developed a web site tool
- Tested the index in a range of applications

What heat exchanger effectiveness value should be used?



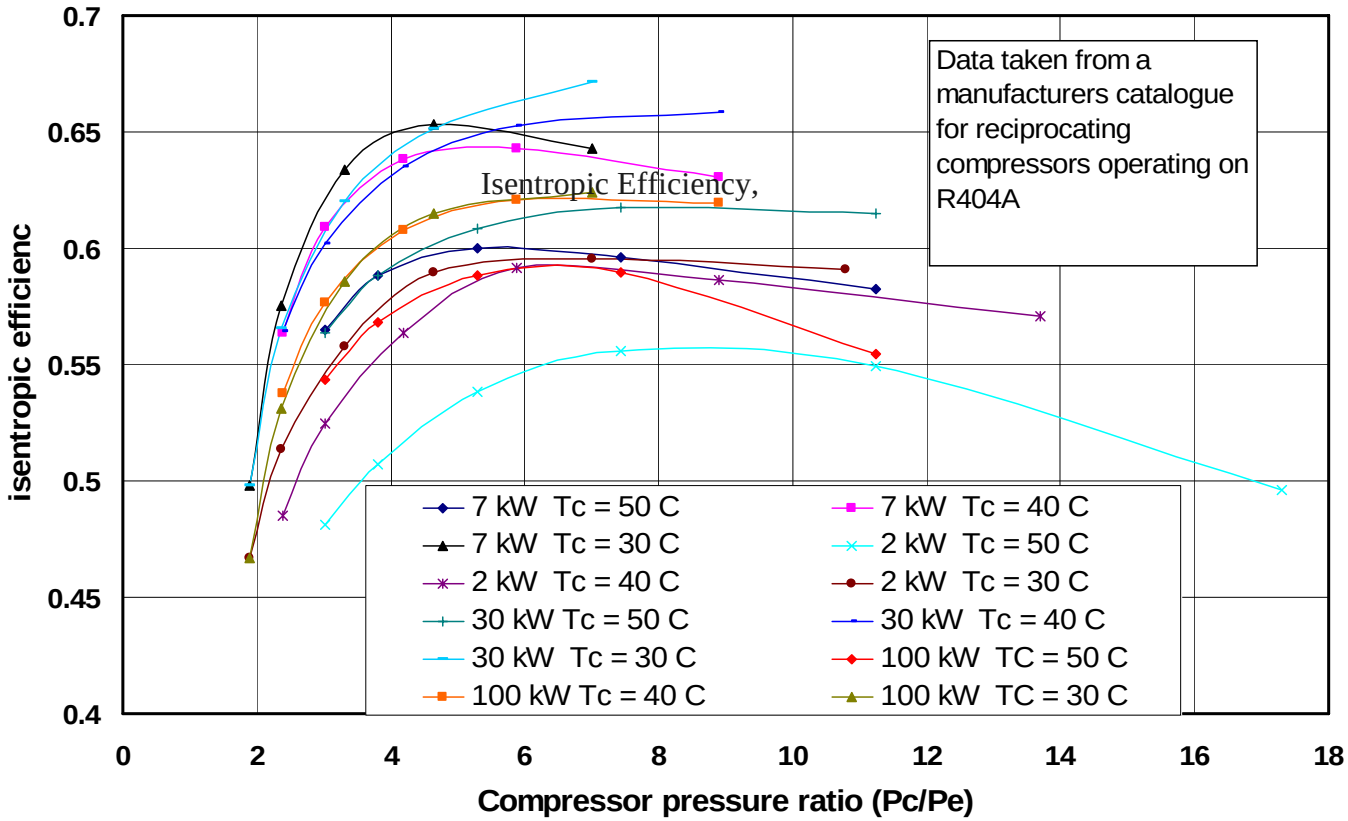
Showing the variation in effectiveness values for a range of proprietary air and water cooled condensers compared with the 'recommended' model of the index effectiveness value

Assume (Tco – Tci) = 10 K (?)

Assume ε = 0.7 (?)

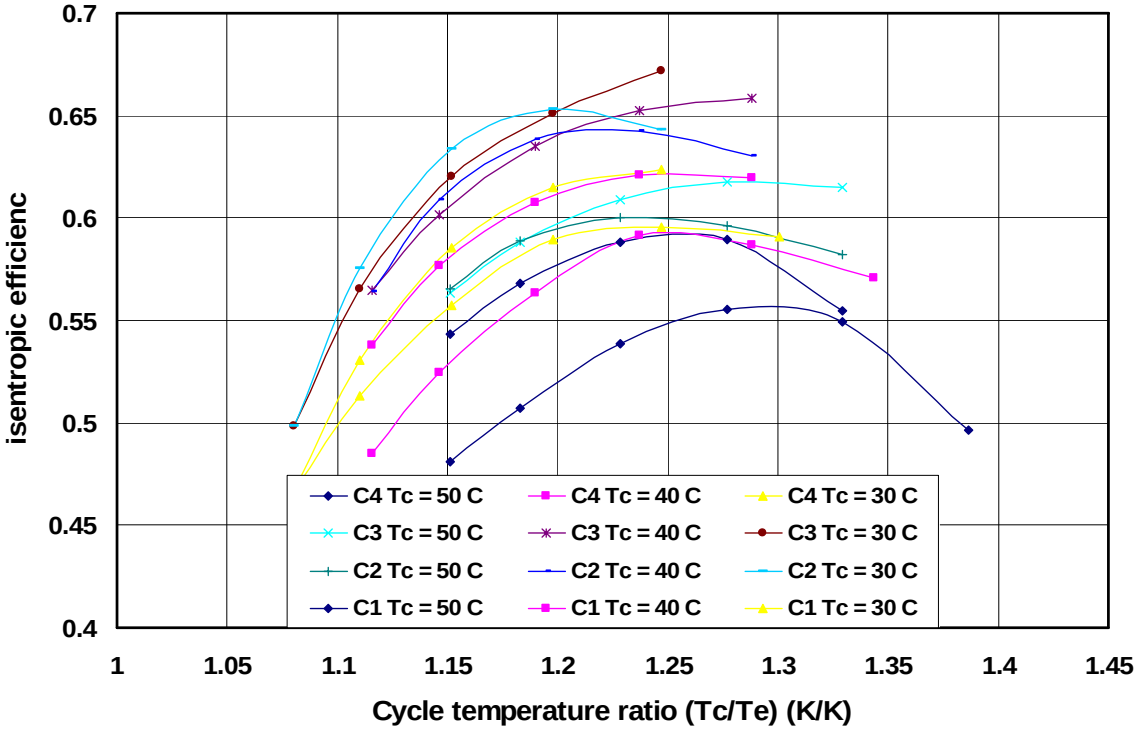
Compressor inefficiencies

$$\text{Isentropic Efficiency, } \eta_s = \frac{\text{isentropic compression power}}{\text{total input power to compressor}}$$



Compressor inefficiencies

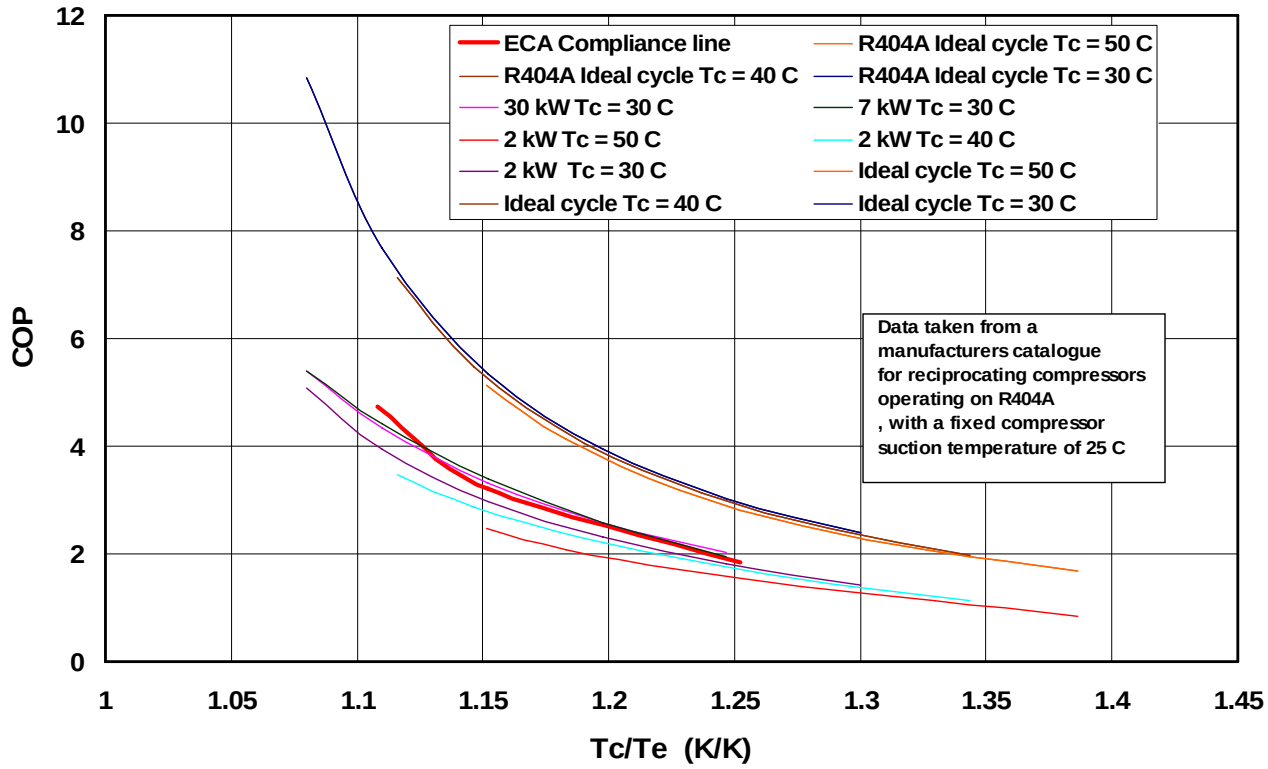
Shown as a function of cycle temperature lift ratio (Tc/Te)



Assume $\eta_s = 0.6$?

Compressor inefficiencies

CoP shown as a function of Tc/Te for various compressors
Compared with ideal VC cycle CoP

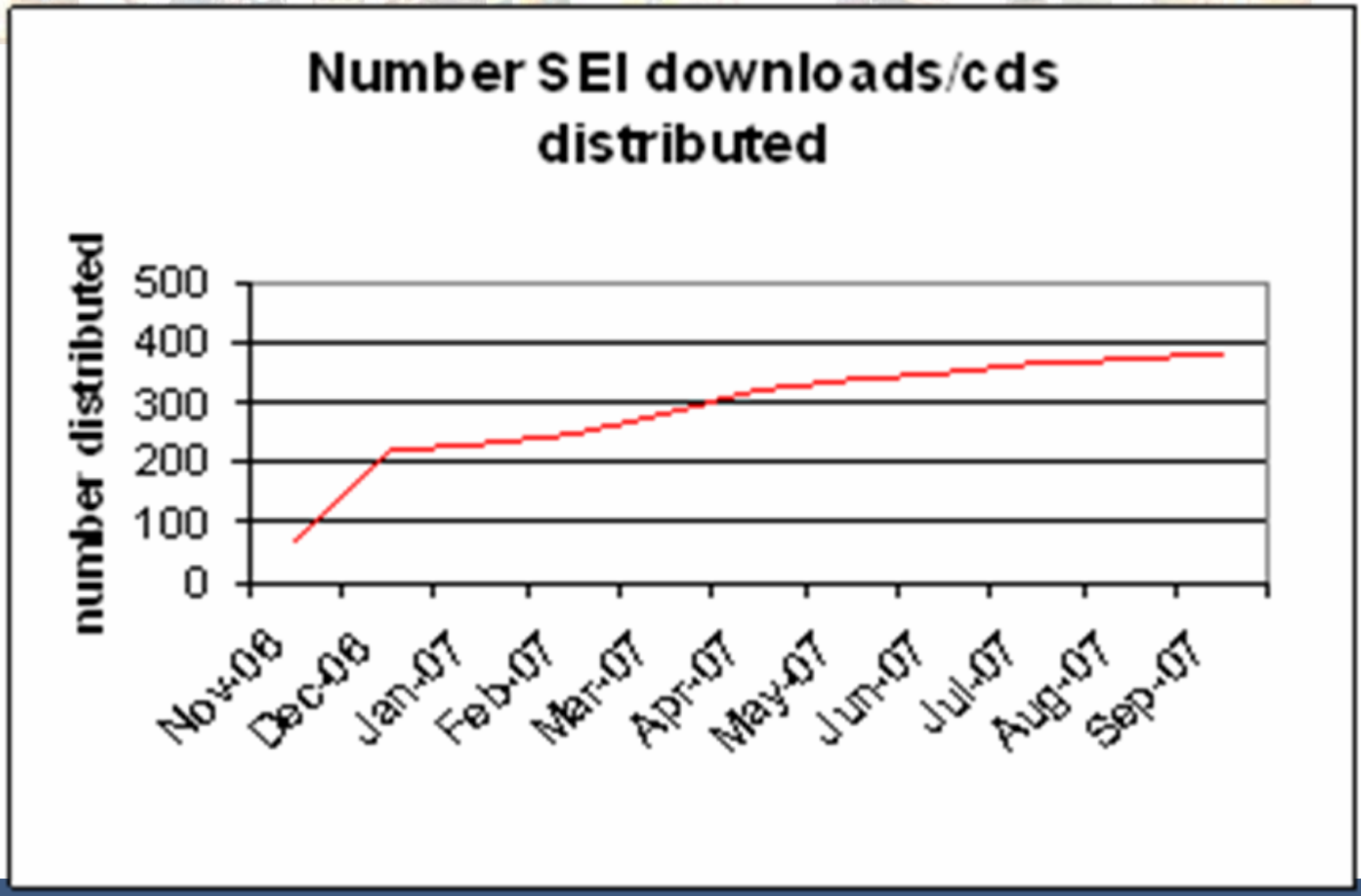


The Web - tool

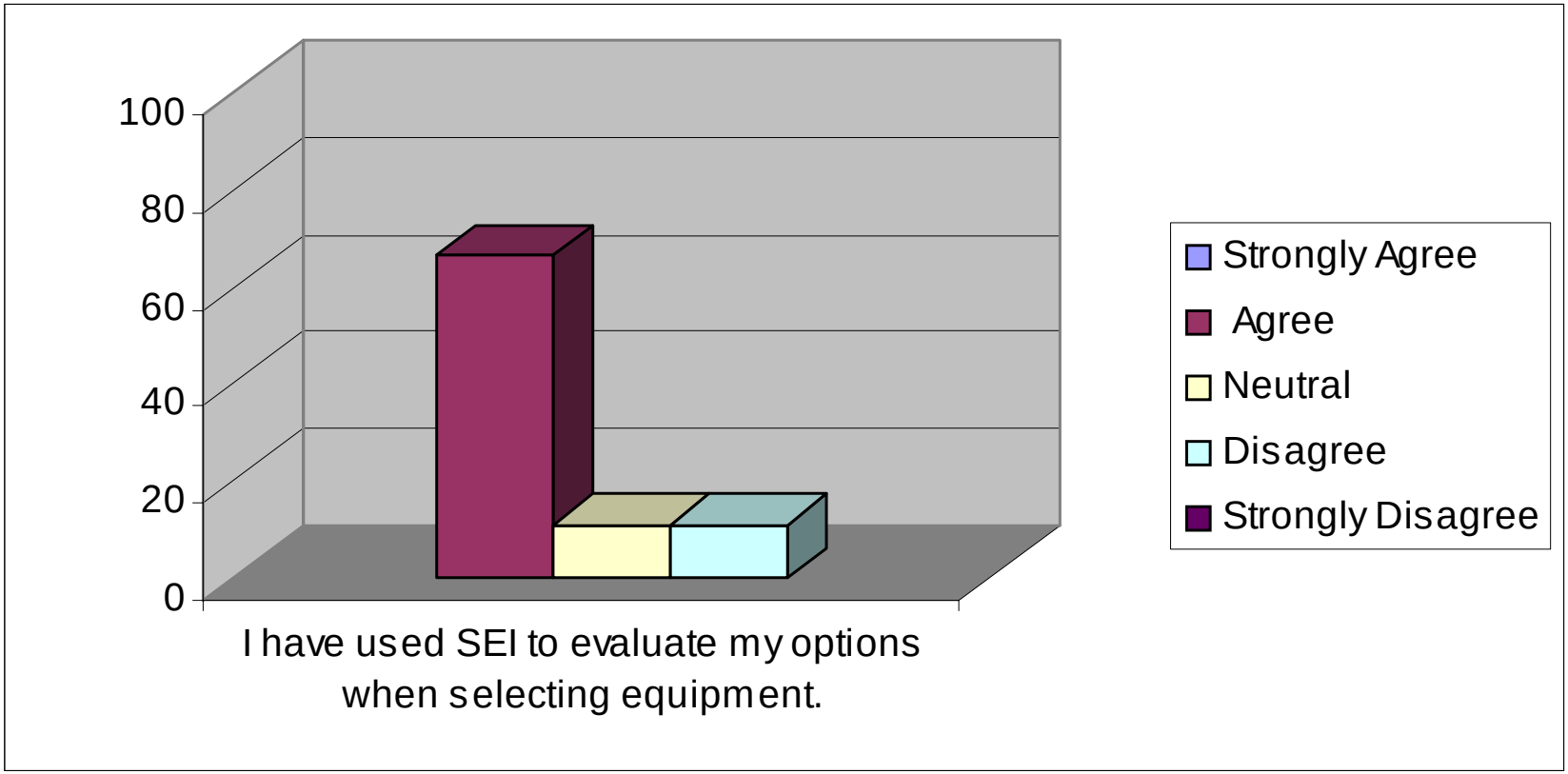
Evaluation – Carbon Available

- 11% of all UK electricity is used for commercial and industrial RAC,
- responsible for 5 million tonnes of Carbon,
- vast differences system performances for the same functionality are possible, dependent on system design
- potentially tens of Millions of Tonnes per year.

Evaluation -Toolkit use



Evaluation -Toolkit use



Evaluation -Toolkit use

"The SEI was quite helpful in pointing out the main factors to pay attention to in respect to the design and operation. A cost comparison between different designs is ongoing (by others) using SEI as the criteria. "

"At the present time we have only tried the application with theoretical data, most of our system are 20+ years old and collecting actual data is required, however, using our best guesses the application demonstrates the possibility of large savings."

"The Index is great in its current form – but it would benefit from further development to optimise Carbon Emissions in specific applications."

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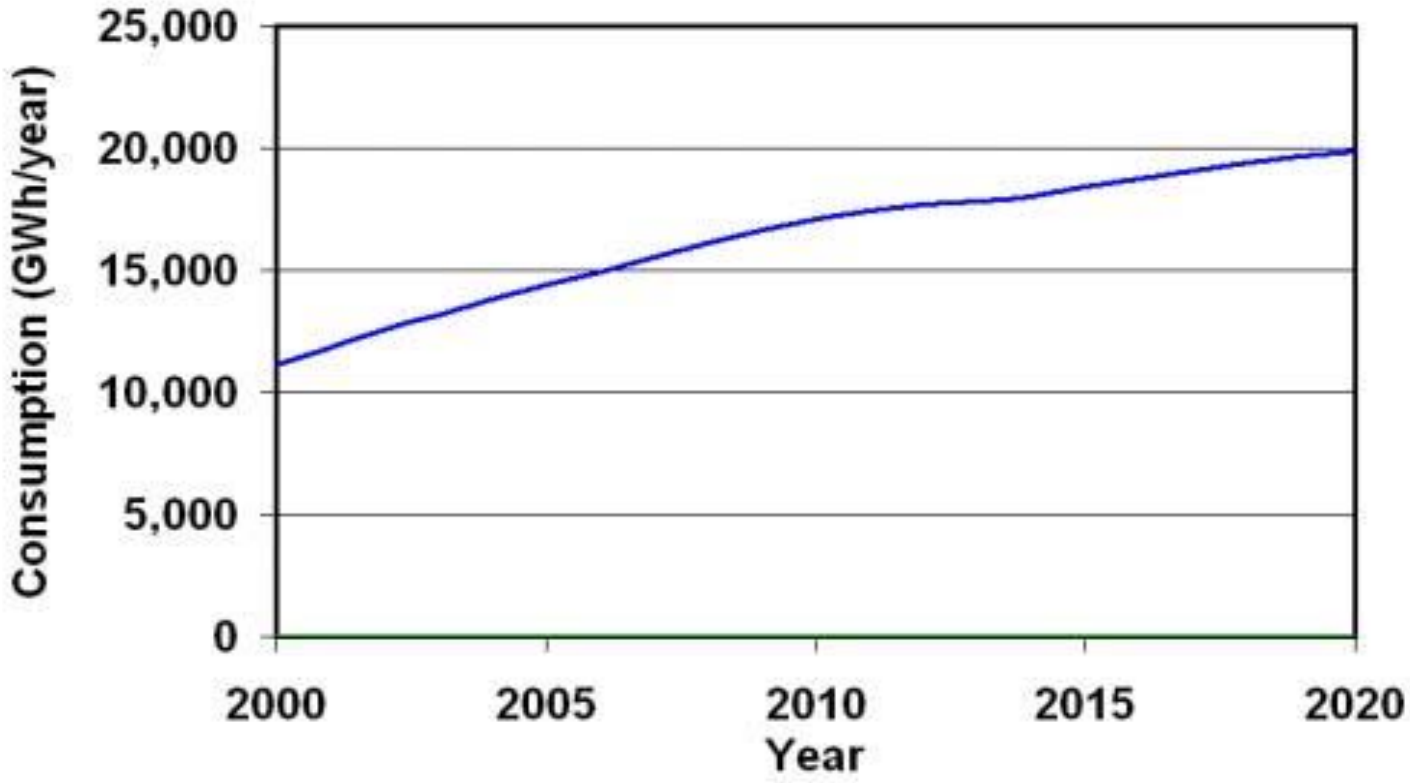
Reference the new Air Conditioning Performance Index tool-kit for The Institute of Refrigeration.

The new ‘Air conditioning efficiency Index’ prepared with the IOR by The London South Back University is, I feel, just the sort of tool this subject desperately needs. The method will need to be tested in application and has potential to be developed to an industry led design guide to take its place in the suite of performance certifying ‘labels’ that encompass compliance for the EPBD, Building Regulations Part ’L’ and much other emerging legislation.

Professor. Terry Wyatt
Consultant Hoare Lea Engineers
Past President CIBSE

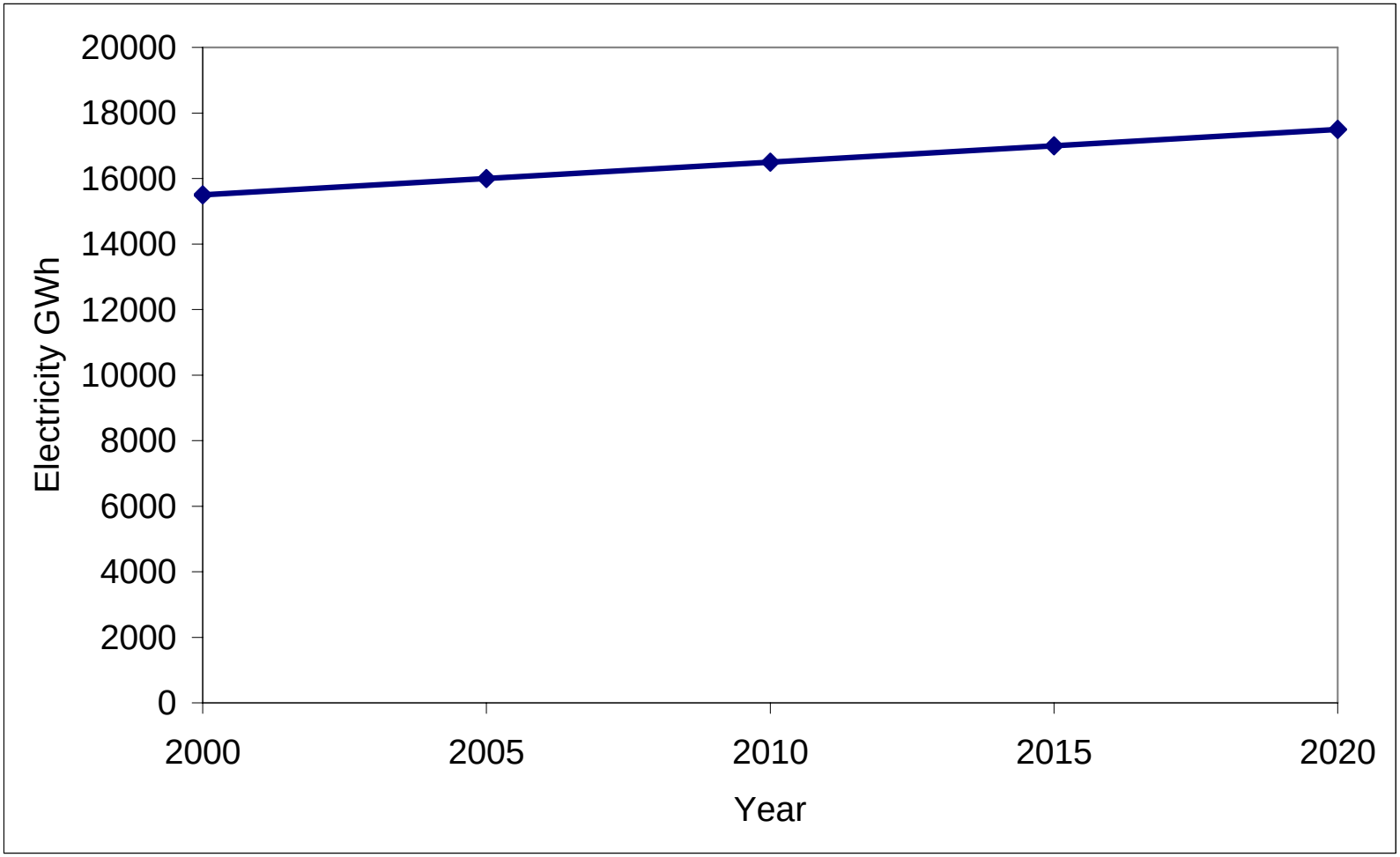
BUT

Predicted Growth in A/C Energy Use



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

Commercial Refrigeration Energy Use



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

How can fully exploit the Toolkit

- Building Regs or Process regs
- ECA

Conclusions

- RAC uses considerable amount of electricity
- Some systems use 3 time energy of others
- Now a systems benchmark exists
- Masses of Carbon to be saved
- How can we make a step change

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SIRAC – Sustainable Innovation in Refrigeration & Air Conditioning

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Pick up a leaflet...

The SEI Index was developed by the IoR with funding from the Carbon Trust. The IoR Steering Group and is acknowledged in this work.

For more info....

http://www.ior.org.uk/ior_software.php