



INDIAN OCEAN
COMMISSION

ENERGY and AIR CONDITIONERS AN OVERVIEW

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Why Air Condition?

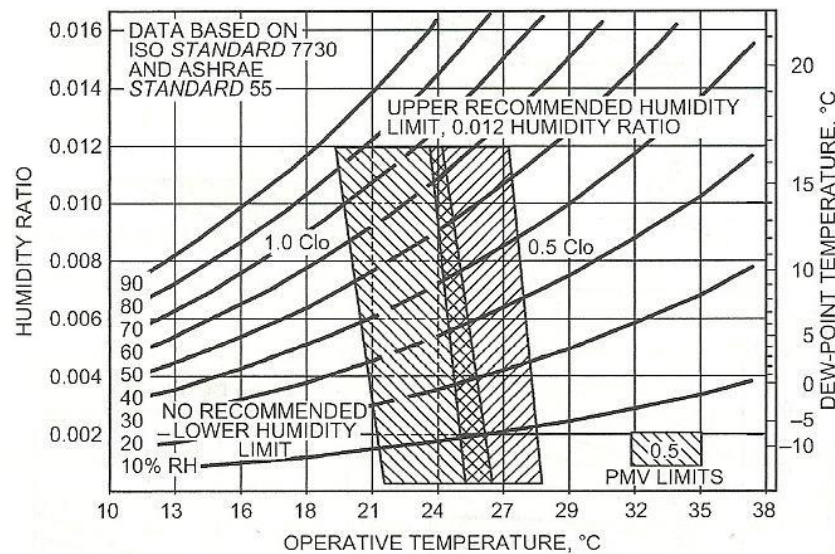
Air conditioning is used to adjust indoor conditions and improve quality of life, productivity, life expectancy ...

The thermal comfort conditions depend on a number of factors:

- Temperature and Relative humidity of air
- Air velocity
- Surface (Radiant) temperature
- Level of activity
- Gender, Age
- Clothing
- Mood
-

Psychrometric Chart

- ASHRAE has provided a psychrometric chart shown below
- The zones regard preferable conditions (complaint rate under 10%) for people of low activity and with usual clothing



Comfort Issues

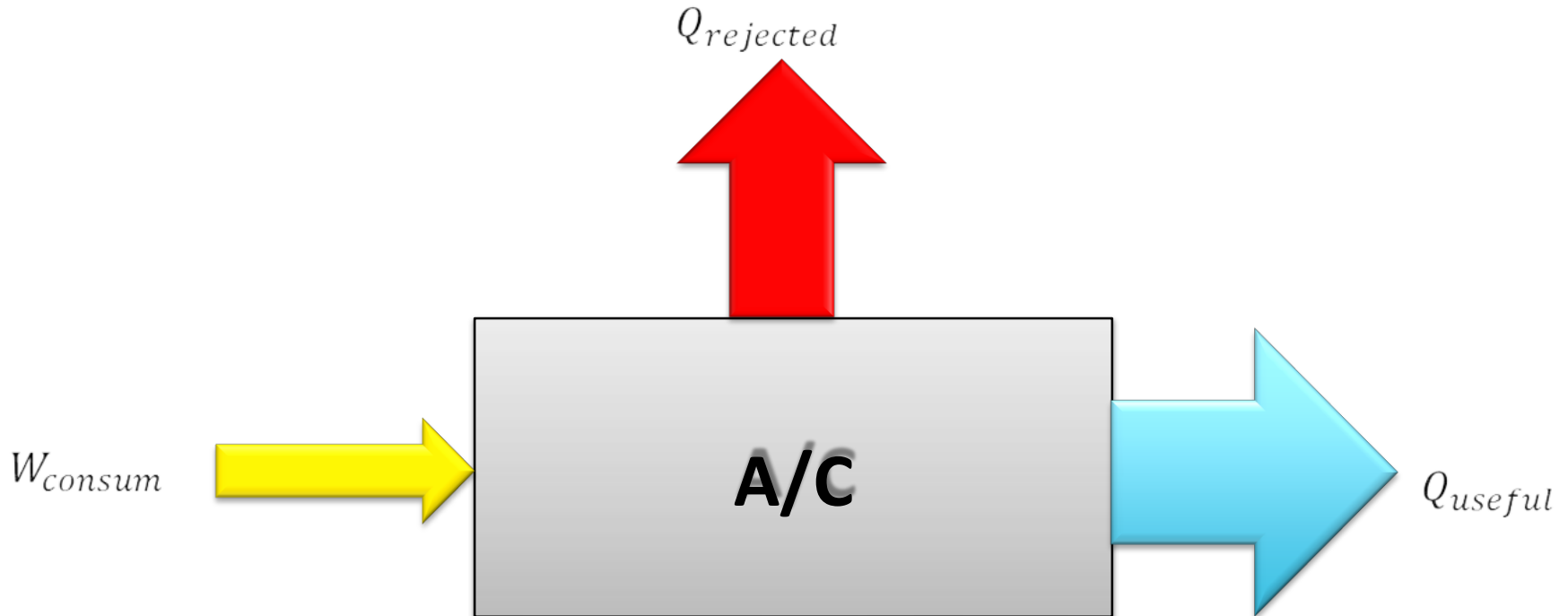
In simple terms ...

- Most people feel comfortable when ambient air temperature is 24-28°C
- Most people prefer a relative humidity between 40-60%
- The temperature of the surfaces should range between 19-29°C
- The air velocity at interior places should not exceed 0.15 m/s in winter (heating) and 0.25m/s in summer (cooling)

Satisfaction level is never 100% !!!

Complaints \leq 5% are acceptable

Air conditioner operating principle



Energy efficiency Ratio – Effectiveness of cooling

$$EER = \frac{Q_{useful}}{W_{consum}}$$

EU efforts for efficient A/C - Labelling

Labeling for many products started around 2000, aiming to increase public awareness

- Dynamic process
- Labels follow (or lead) technical developments

Brief history of EU AC label evolution

- Initially based on EER (Energy Efficiency Ratio)
- and then on SEER (Seasonal EER)

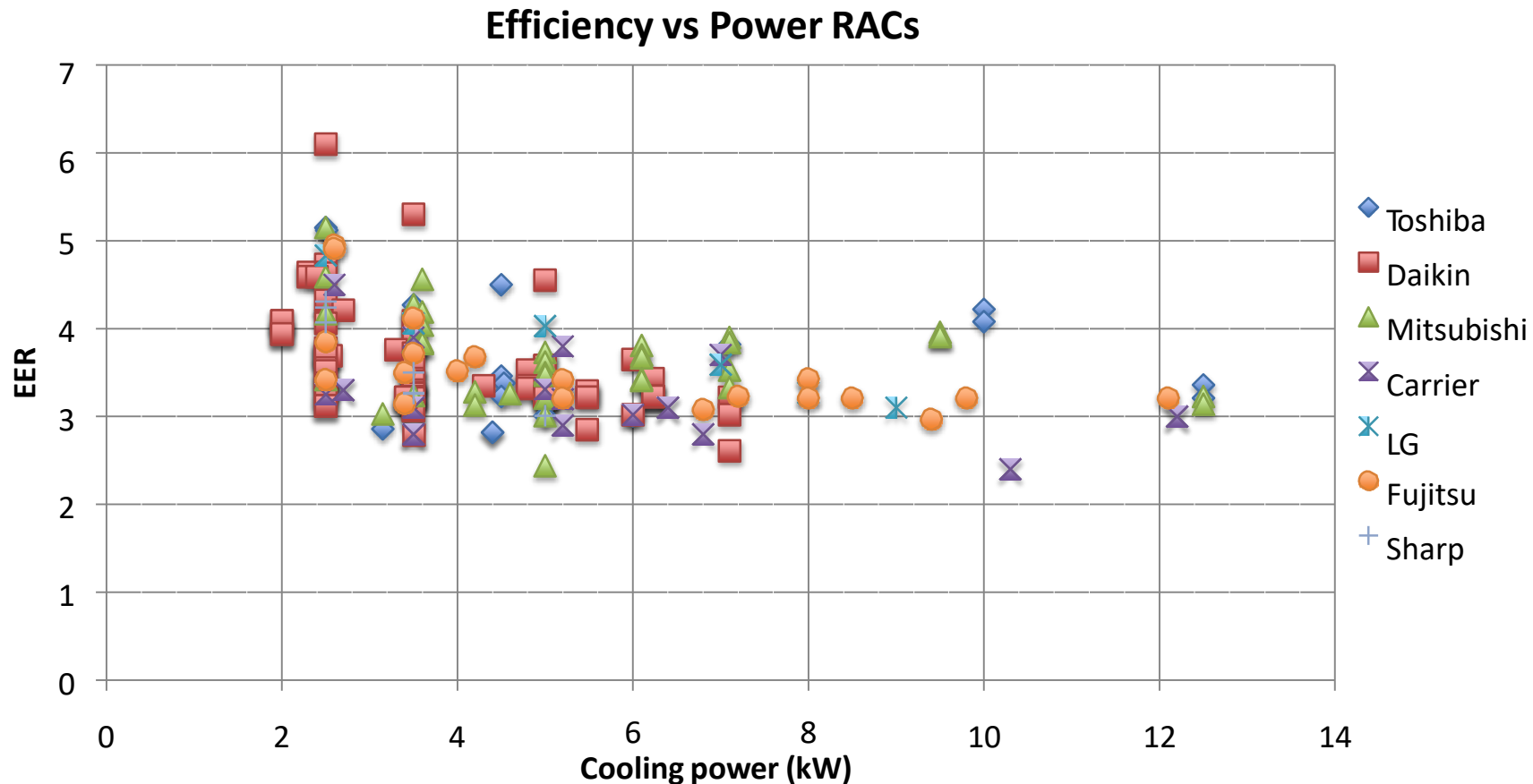
EU Directive 2002/31/EC – Energy Label for ACs

Energy		Air-conditioner	
Manufacturer		Logo	
Outside unit		ABC 123	
Inside unit		ABC 123	
More efficient 			
Less efficient 			
Annual energy consumption, kWh in cooling mode <small>(Actual consumption will depend on how the appliance is used and climate)</small>		X.Y	
Cooling output kW		X.Y	
Energy efficiency ratio <small>Full load (the higher the better)</small>		X.Y	
Type			
Cooling only	—		
Cooling + Heating	—		
Air cooled	—		
Water cooled	—		
Heat output kW		X.Y	
Heating performance <small>A: higher G: lower</small>		A B C D E F G	
Noise <small>(dB(A) re 1 pW)</small>			
Further information is contained in product brochures			
<small>Norm EN 814 Air-conditioner Energy Label Directive 2002/31/EC</small>			

Energy efficiency class	Split and multi-split appliances
A	$3,20 < \text{EER}$
B	$3,20 \geq \text{EER} > 3,00$
C	$3,00 \geq \text{EER} > 2,80$
D	$2,80 \geq \text{EER} > 2,60$
E	$2,60 \geq \text{EER} > 2,40$
F	$2,40 \geq \text{EER} > 2,20$
G	$2,20 \geq \text{EER}$

Indicative analysis on existing split systems

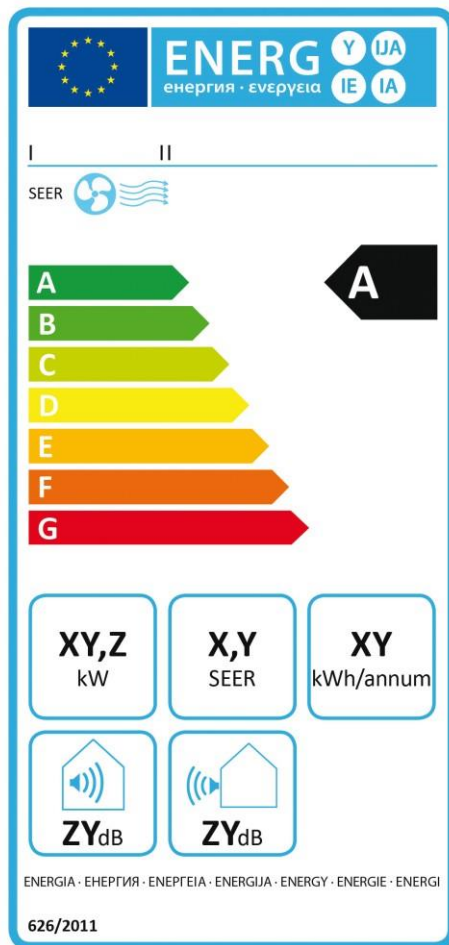
Study of 7 brands commercially available in the EU - 2016



EU Directive 626/2011 – Cooling ACs

2013-14

Moved from EER to SEER



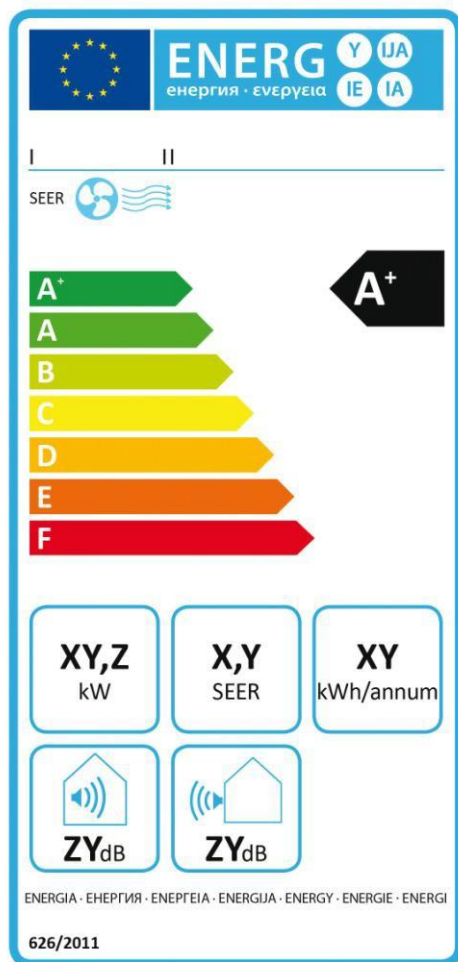
Energy efficiency classes for air conditioners, except double ducts and single ducts

Energy Efficiency Class	SEER	SCOP
A+++	$\text{SEER} \geq 8,50$	$\text{SCOP} \geq 5,10$
A++	$6,10 \leq \text{SEER} < 8,50$	$4,60 \leq \text{SCOP} < 5,10$
A+	$5,60 \leq \text{SEER} < 6,10$	$4,00 \leq \text{SCOP} < 4,60$
A	$5,10 \leq \text{SEER} < 5,60$	$3,40 \leq \text{SCOP} < 4,00$
B	$4,60 \leq \text{SEER} < 5,10$	$3,10 \leq \text{SCOP} < 3,40$
C	$4,10 \leq \text{SEER} < 4,60$	$2,80 \leq \text{SCOP} < 3,10$
D	$3,60 \leq \text{SEER} < 4,10$	$2,50 \leq \text{SCOP} < 2,80$
E	$3,10 \leq \text{SEER} < 3,60$	$2,20 \leq \text{SCOP} < 2,50$
F	$2,60 \leq \text{SEER} < 3,10$	$1,90 \leq \text{SCOP} < 2,20$
G	$\text{SEER} < 2,60$	$\text{SCOP} < 1,90$

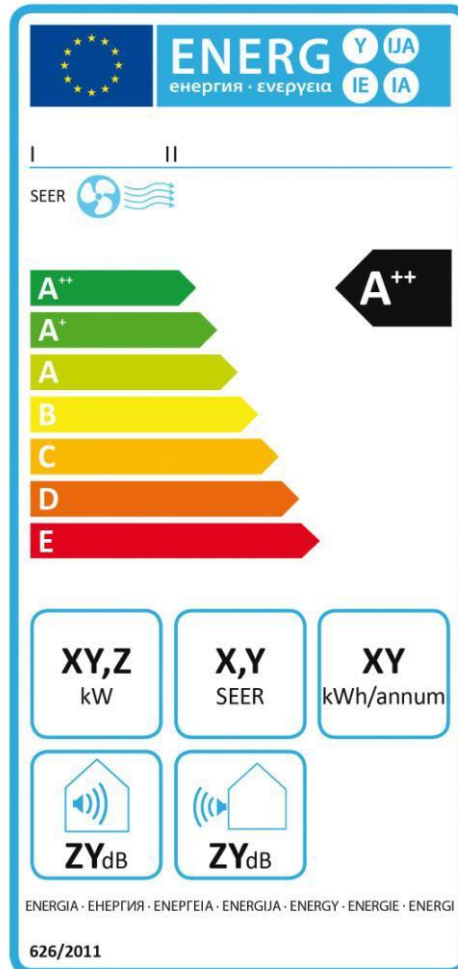
Going from A-G to A+++ - D &
Planning to return back to A..G scale

EU Directive 626/2011 – Cooling ACs

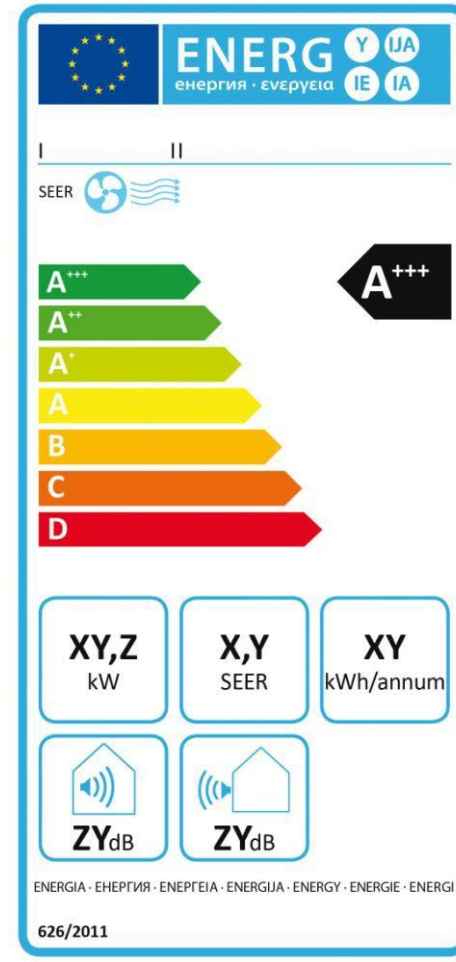
2015-16



2017-18



2019 - ...



Certification bodies – e.g. EUROVENT

Need to have Uniform standards across Industry and Products

EUROVENT – a non profit AC industry association

- Products in > 20 categories
 - Small ACs
 - Big Chillers Air – Water cooled
 - Variable Refrigerant Volume/Flow
 - Fan Coils
 - Air Handling Units
 - ...

Participation on voluntary basis

Products from almost all major manufacturers

Certification – Eurovent

Manufacturers certify products in independent certified Labs

All products (eg split units) from a manufacturer included in database

Randomly tested / checked

If test reveals problems with values in 1 product - all products are taken out of the database for 1 year and each one is retested and pays a fee to reenter database

Discussion groups between Eurovent and Manufacturers of similar products (eg Liquid chillers) define Energy classes – before the EU

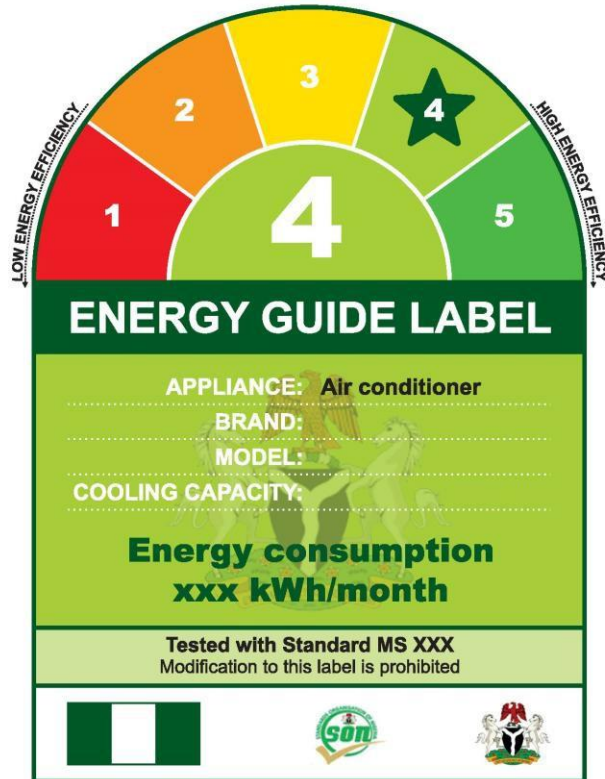
“Eurovent Certified” label is becoming a prerequisite in most bids.

... on products

... in brochures



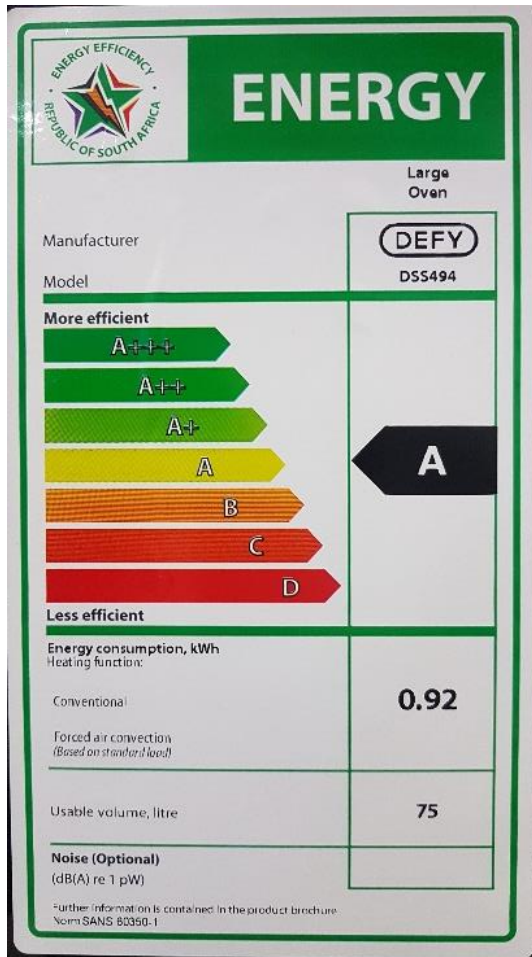
The Nigerian Energy Label



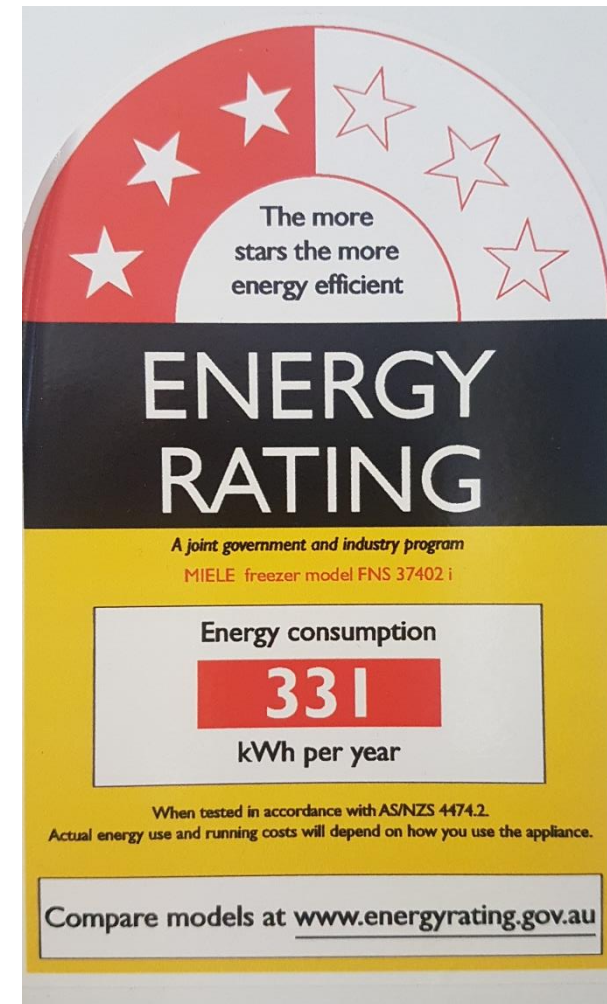
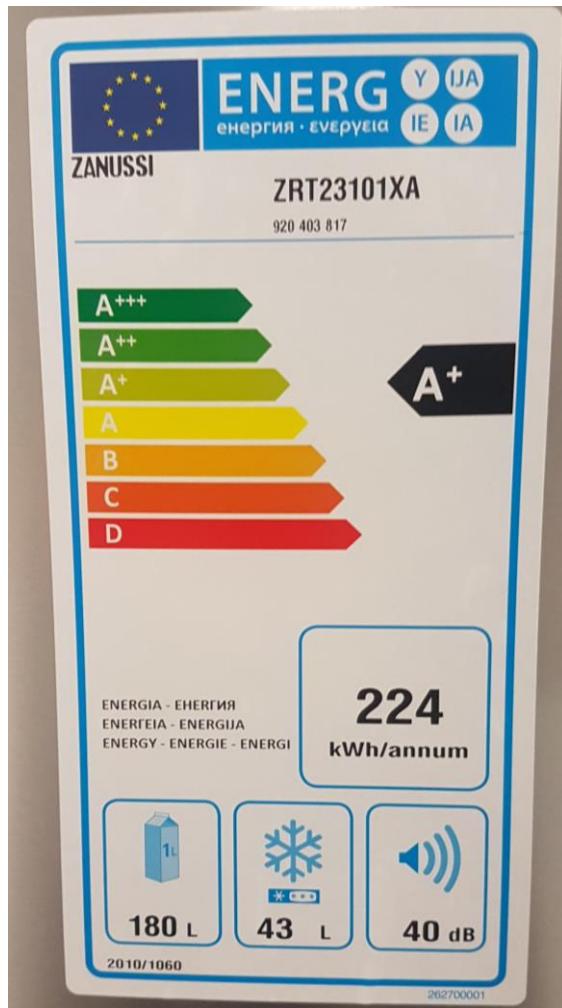
Energy Class	EER
5	$EER \geq 5.00$
4	$4.20 \leq EER < 5.00$
3	$3.60 \leq EER < 4.20$
2	$3.20 \leq EER < 3.60$
1	$2.80 \leq EER < 3.20$

kWh/month to be determined

Labels from other countries - Zambia

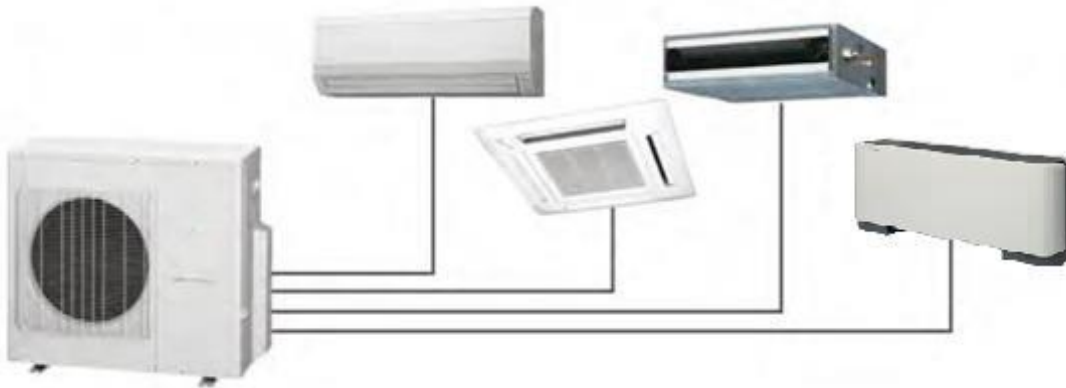


Labels from other countries - Seychelles



Types of Air Conditioners

- Window Units
- Split Systems
- Mobile Units
- Central Systems
 - Liquid (water) systems
 - Variable Refrigerant Volume/Flow



Sizing Air Conditioners

Sizing is very important – usually overlooked – issue

- Oversized → decreased comfort
 - High air speeds
 - Improper dehumidification
 - Heat/cold islands
 - Frequent start ups → increased wear
- Under sized
 - Poor comfort conditions during extreme conditions
- Properly sized
 - Proper functioning & energy consumption

Methods of Sizing Air Conditioners

- Factors considered
 - Building shell / mass
 - People
 - Lights, equipment
 - Ventilation
 -

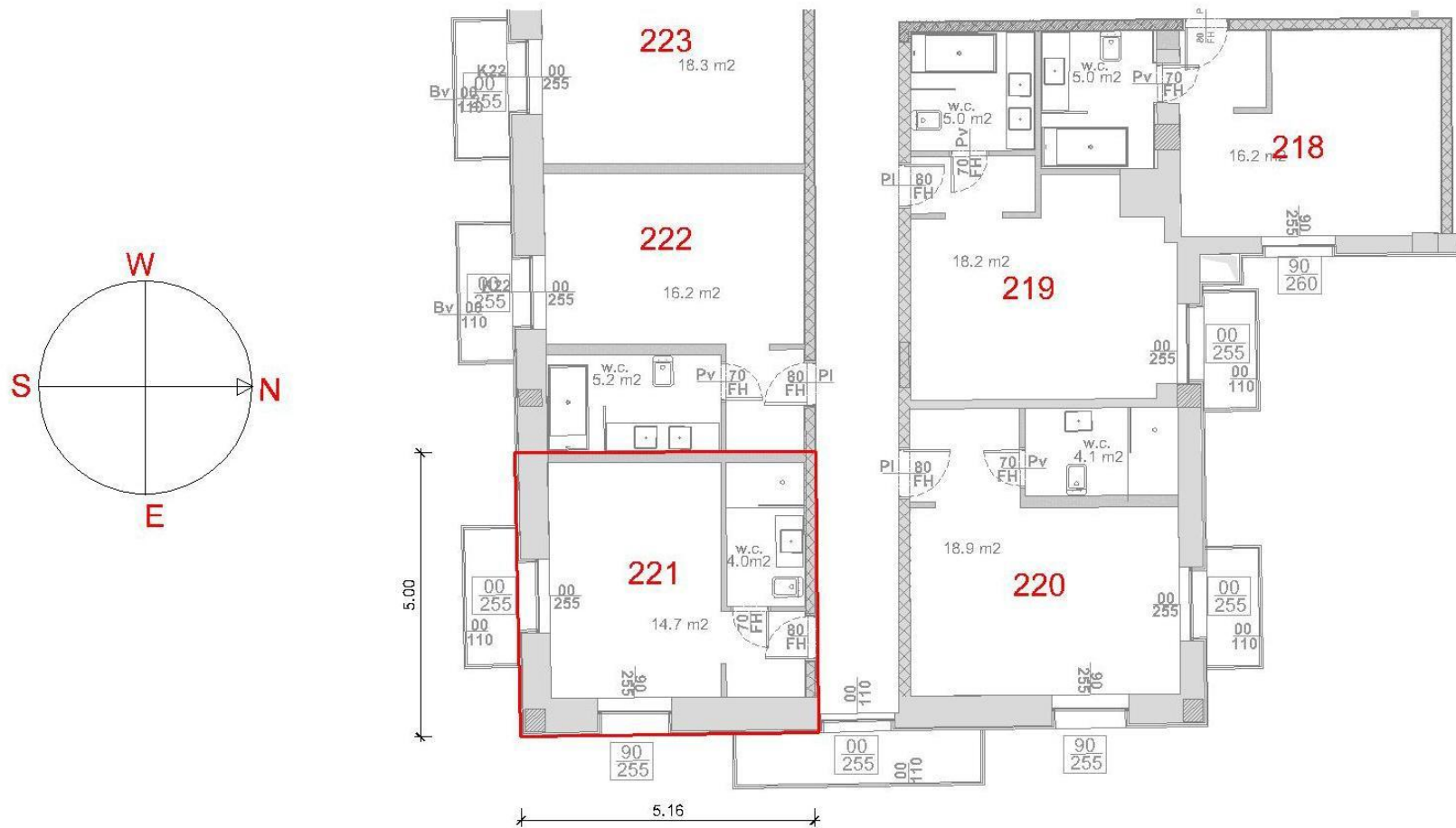
Analytical Calculation methods (ASHRAE, EN ...)

- Cooling Load Temperature Difference (CLTD)
- Transfer Function Method (TFM)
- Radiant Time Series method (RTS)
- ...

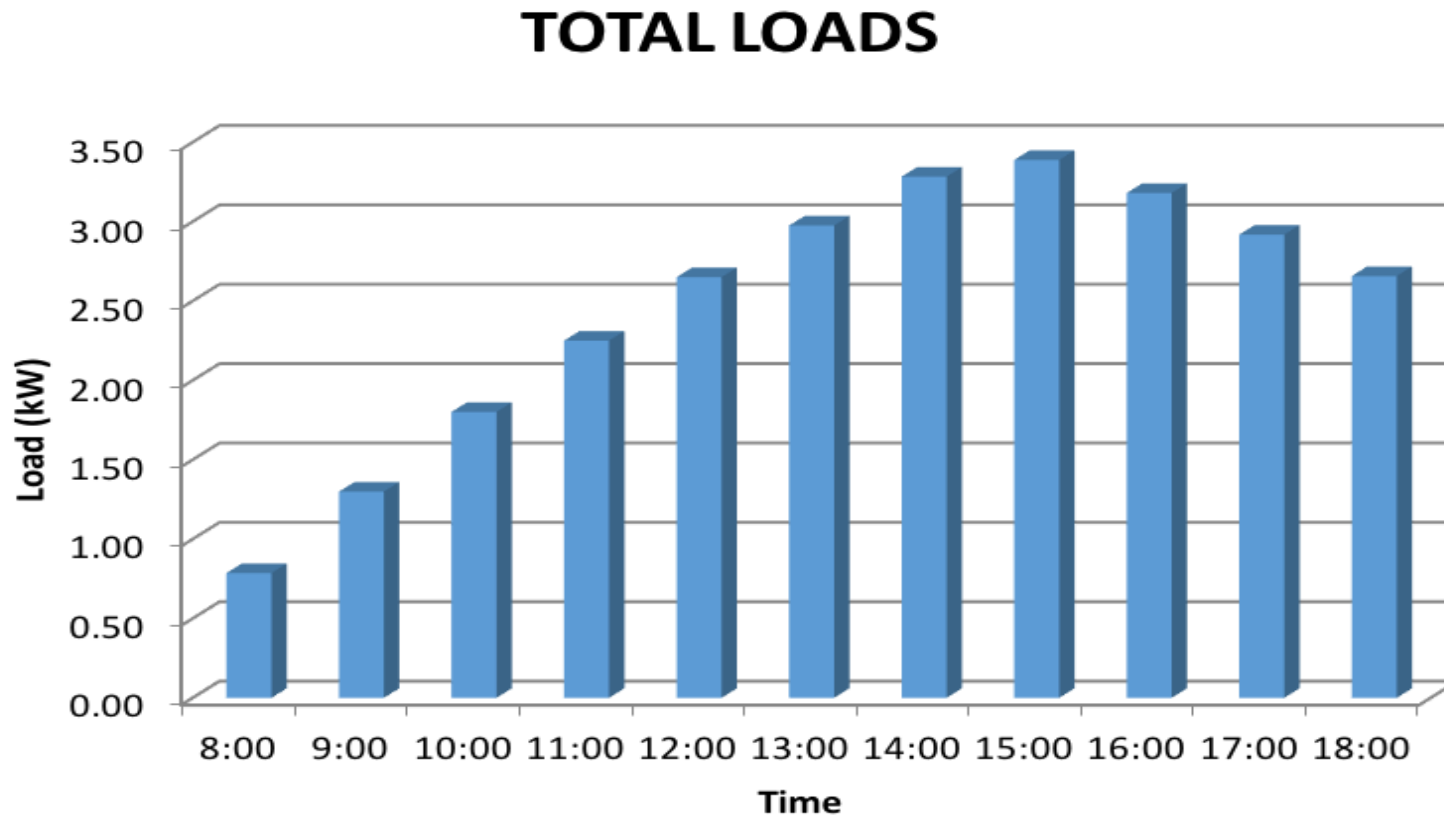
Empirical methods

- $Xx-yy \text{ W/m}^2$

Example Calculation - Hotel Room



Room Loads



Available units – 2.5, 3.5, 5, 6 kW – Which one should we choose ?

Refrigerants - Properties

Every Unit contains refrigerants, with desired

- Chemical properties
 - Non-toxic
 - Non-flammable
 - Chemically stable
 - Non-corrosive
 - Easy to track in case of leakages
 - Compatible with the compressor's lubricant
- Physical properties
 - Temperatures and latent heat for high efficiency

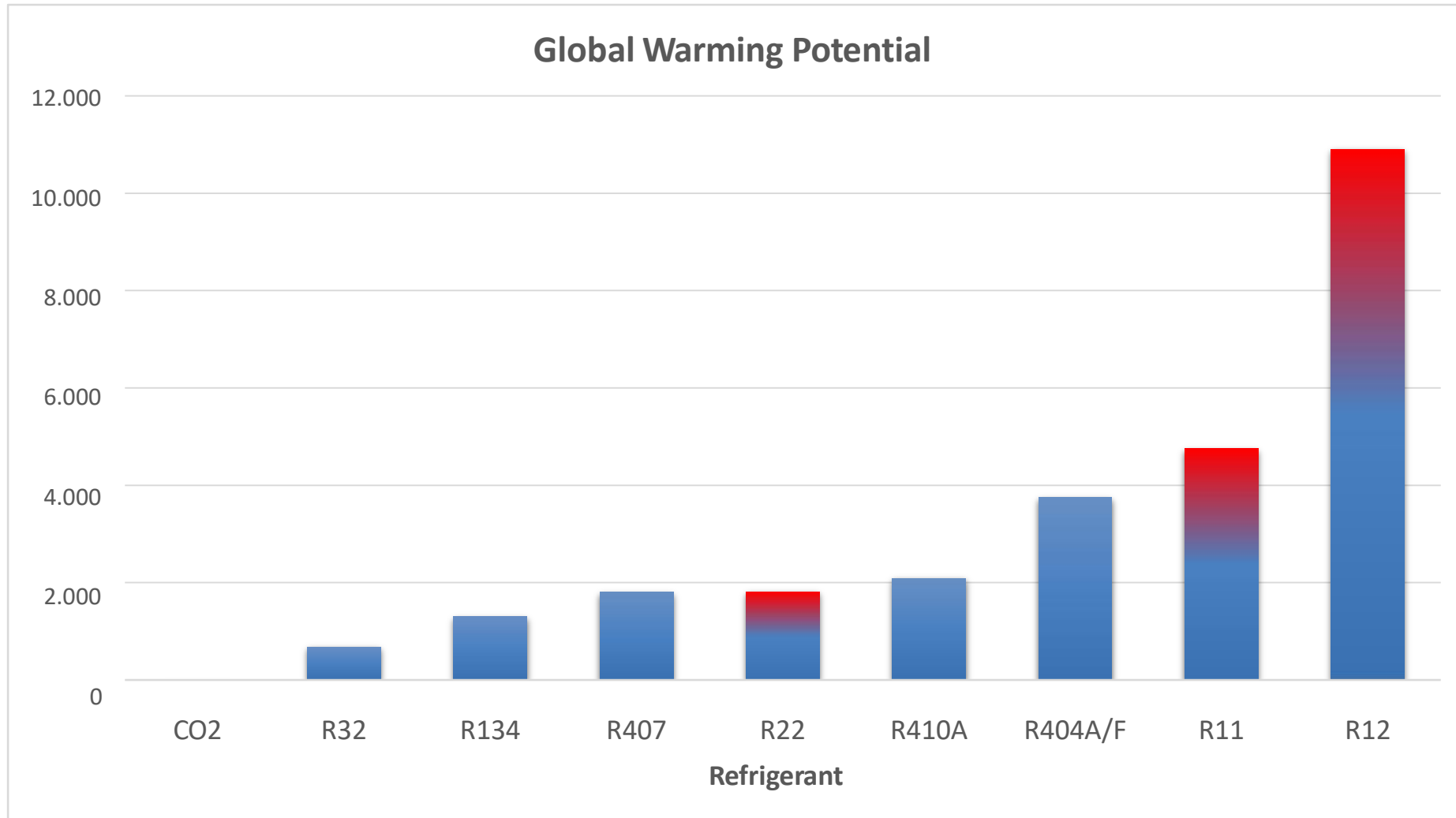
Properties – Environmental considerations

Can cause great environmental damage. The 2 basic indicators are

- ODP – Ozone Depletion Potential
 - Ability to damage Ozone layer in atmosphere
 - Early refrigerants were very harmful
 - 0 potential is allowed nowadays

- GWP Global Warming Potential
 - Effect on Greenhouse warming from leakage in 100 years
 - In EU Max allowed GWP=150 for cars – soon to come to houses

Refrigerants - GWP



Installation

Proper installation very important to efficient operation and long life.

Quality of installation decreases with increasing number of daily installations.

- Indoor Unit
 - Central location – even distribution
 - Bedrooms - away from beds
 - Placement on walls $H > 2\text{m}$
 - Room Aesthetics
 - Concealed (ducted) – distribution outlets
 - Accessible for maintenance

Installation (2)

- Outdoor Unit
 - Open space – no obstacles
 - Shaded if possible
 - Insulated pipes
 - Accessible for maintenance

Installation based on manufacturer's instructions

Always take air out of pipes

Done carefully by professionals !



Maintenance

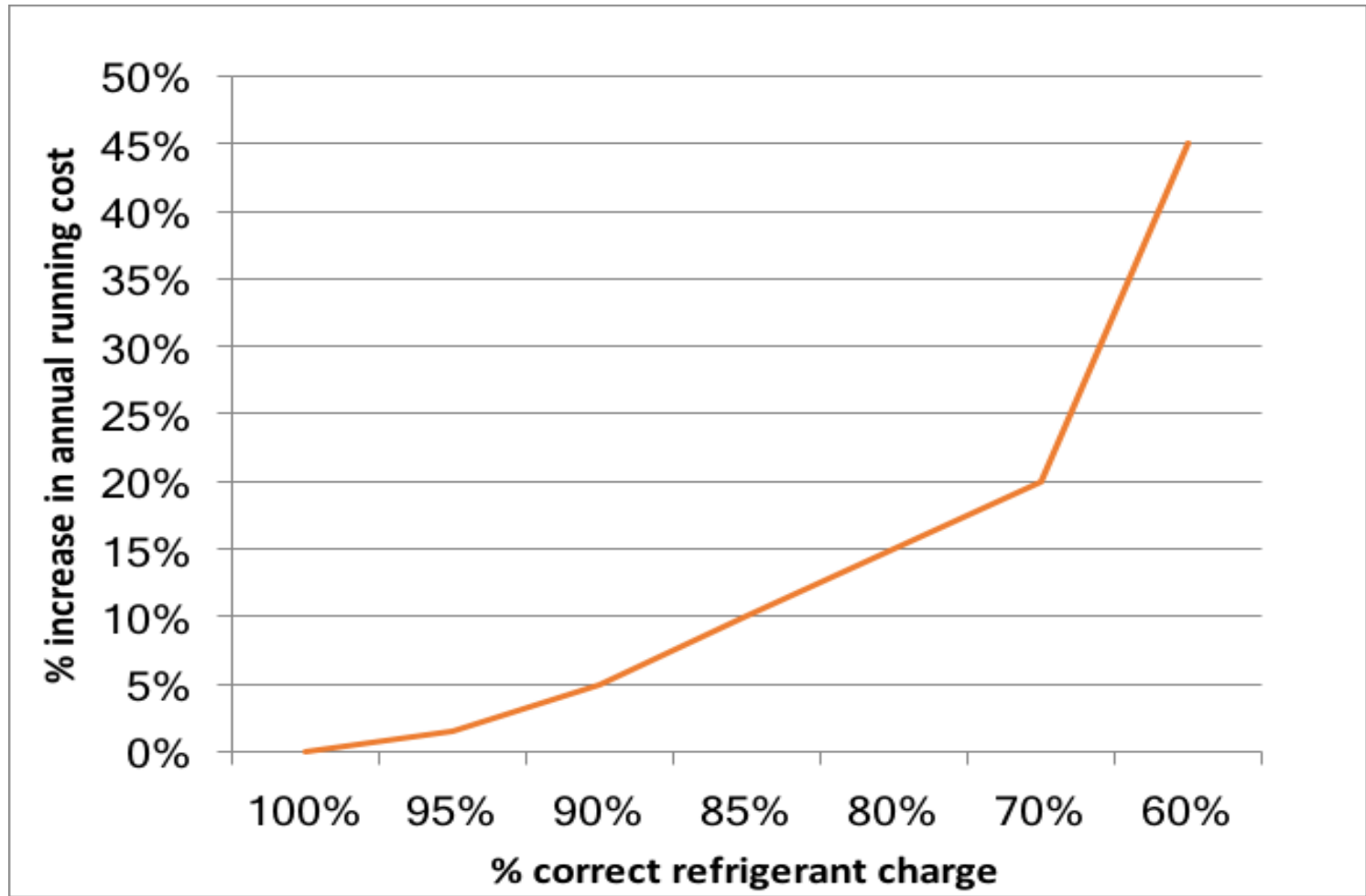
Regular maintenance absolutely essential to efficient operation.

- AC interacts with an environment containing
 - Dust
 - Dirt
 - Humidity
 - Chemicals
- Well maintained units
 - Operate / live longer
 - Consume less energy

If people do not plan to maintain – meaningless to buy an efficient AC !

- Frequency of maintenance depends on location / environment
- Maintenance to be performed by certified technicians.

Example – Effect of refrigerant content



Maintenance

Create a mechanism to enforce maintenance through

- Education – Information campaigns
- Incentives
- Legal measures

- Give priority to
 1. Public buildings
 2. Large buildings
 3. Homes

Conclusions

There should be an energy label applied across the country
... possibly valid for many electric appliances

Beginning will be difficult but - if used right - it gives a competitive advantage to country and local industry

- Create mechanisms to educate and/or certify
 - Consumers
 - Installers
 - Maintenance



Thank you !

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