



"Fiat Lux" - Let there be light

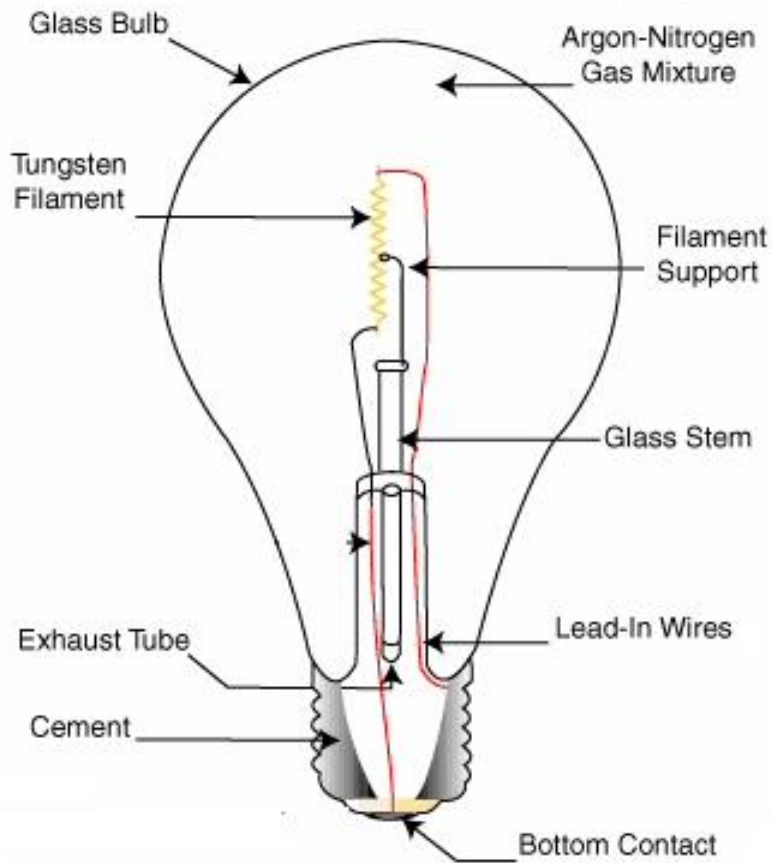
LED lighting "heads up" - Feb. 2010
Stan. SWAN



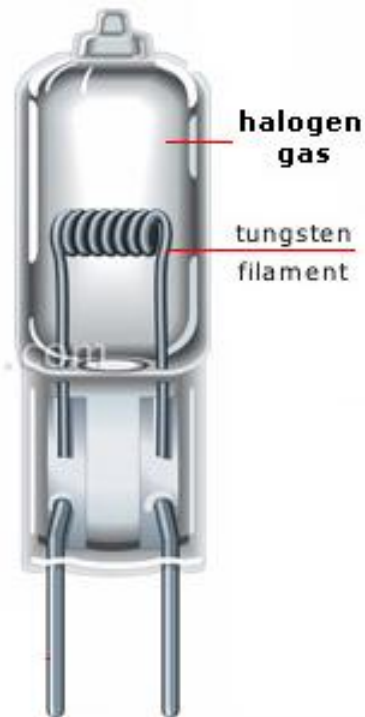
**Carbon filament
lamp**



**Joseph SWAN
(1828 - 1914)**



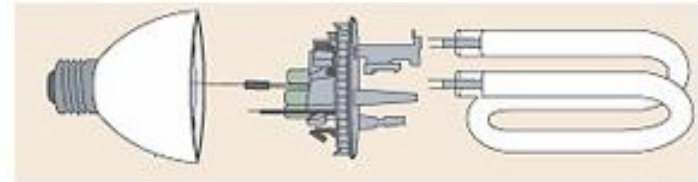
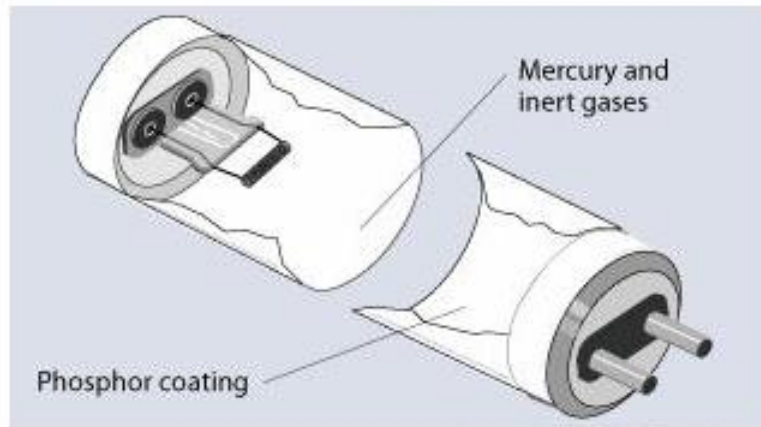
Tungsten filament



Halogen



Halogen - in regular bulb








Classic fluorescent and recent compact fluorescent lamps (CFL)

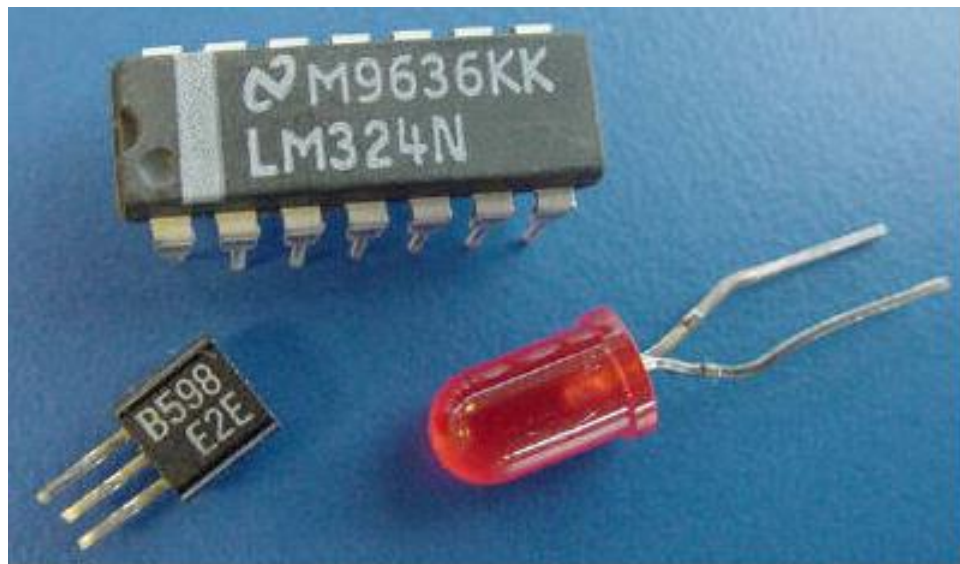
BUT CFLs are complex, with toxic contents



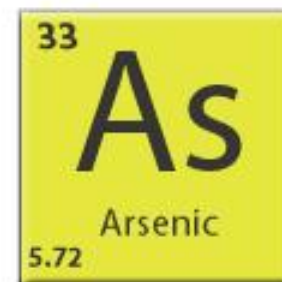
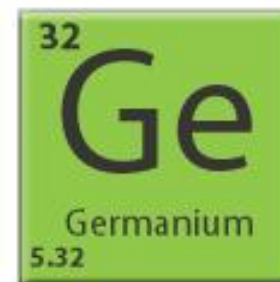
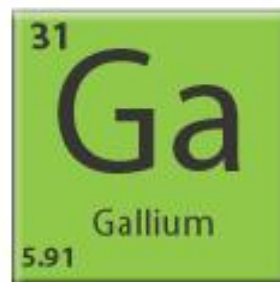
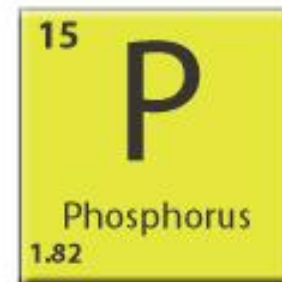
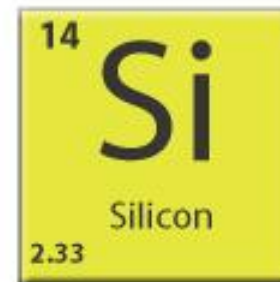
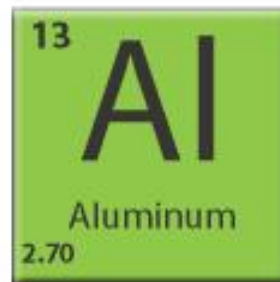
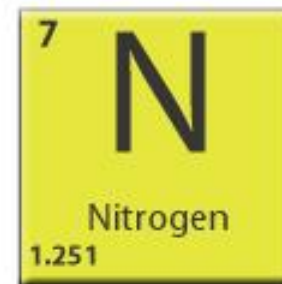
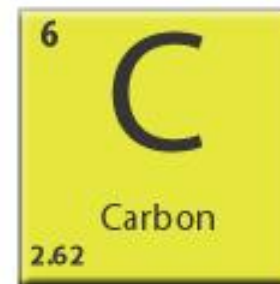
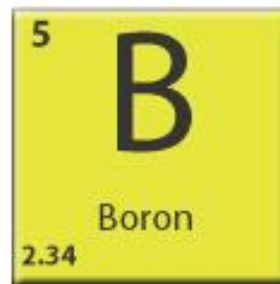
**Don't put
them in
the trash.**

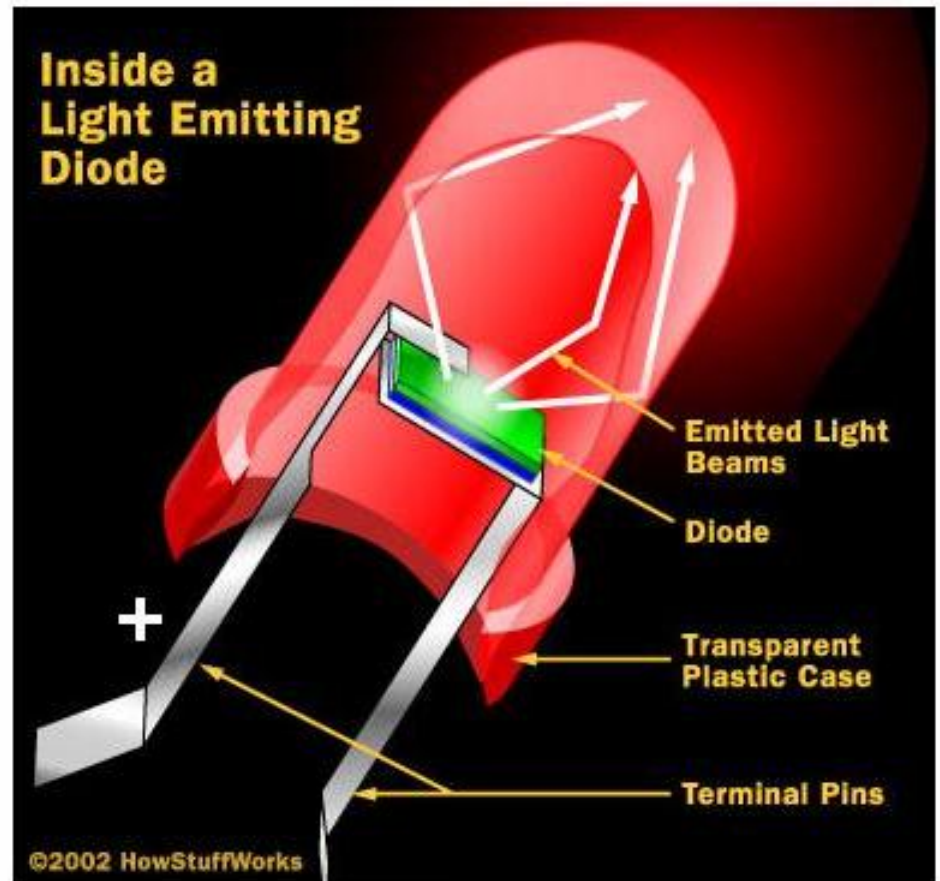


	<ancient	19th C -	20th century...		21st
					
				HID etc	LED
Efficiency lm/W	1	10-15	70-100	70-100	Target 50-110
Efficiency (rel.)	<1%	5-9%	25-30%	30-35%	Target 20-30%



20th century electronics advances mean semiconductors - especially silicon- have been extensively investigated





Light colour (& driving voltage) is a function of the LED doping material - surround plastic only acts as a guide

Light Emitting Diodes (L.E.D.s) have only been widely and cheaply available for just a few years, but they have been a lighting revolution!

- Highly efficient (often 10 times better than filament lamps)
- Ideal for low maintenance night light or bright traffic lights - at night LED traffic lights 10 km away across the harbour in Wellington can be clearly seen from Eastbourne !!
- Suit solar powering- a revolution in the less developed world
- Cheap – now as low as 10 cents each! * Rugged & reliable
- Run cool & on safe low voltages * “Never” wear out !!
- Available in many colours, brightness & flashing patterns.
- BUT-only work one way round & need connecting correctly
- Probably the most humanitarian educational invention in the last 10 years- now allowing crafts/reading/homework etc after dark in regions (much of Africa etc) that had no night lighting.

Old style hot wire filament lamps are now almost obsolete – this may be one of the last decades that they're available, and even CFLs are threatened. LED lighting looks the way ahead.

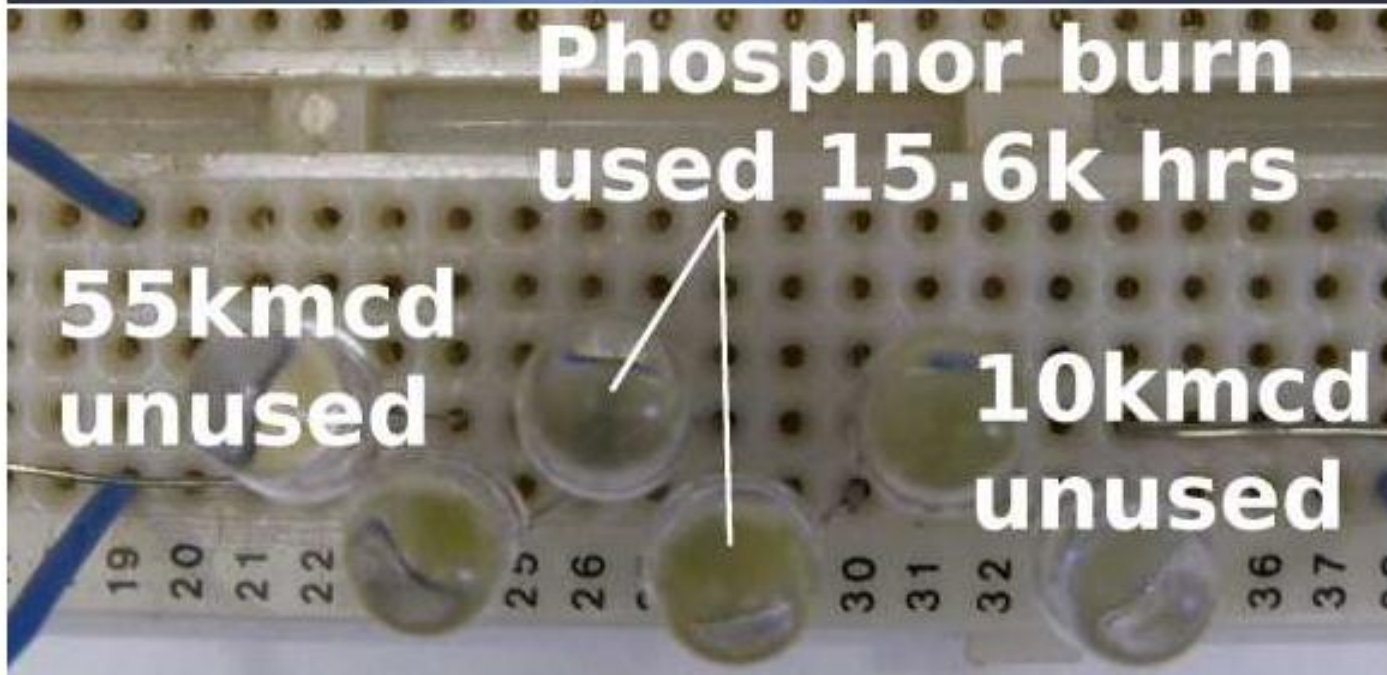
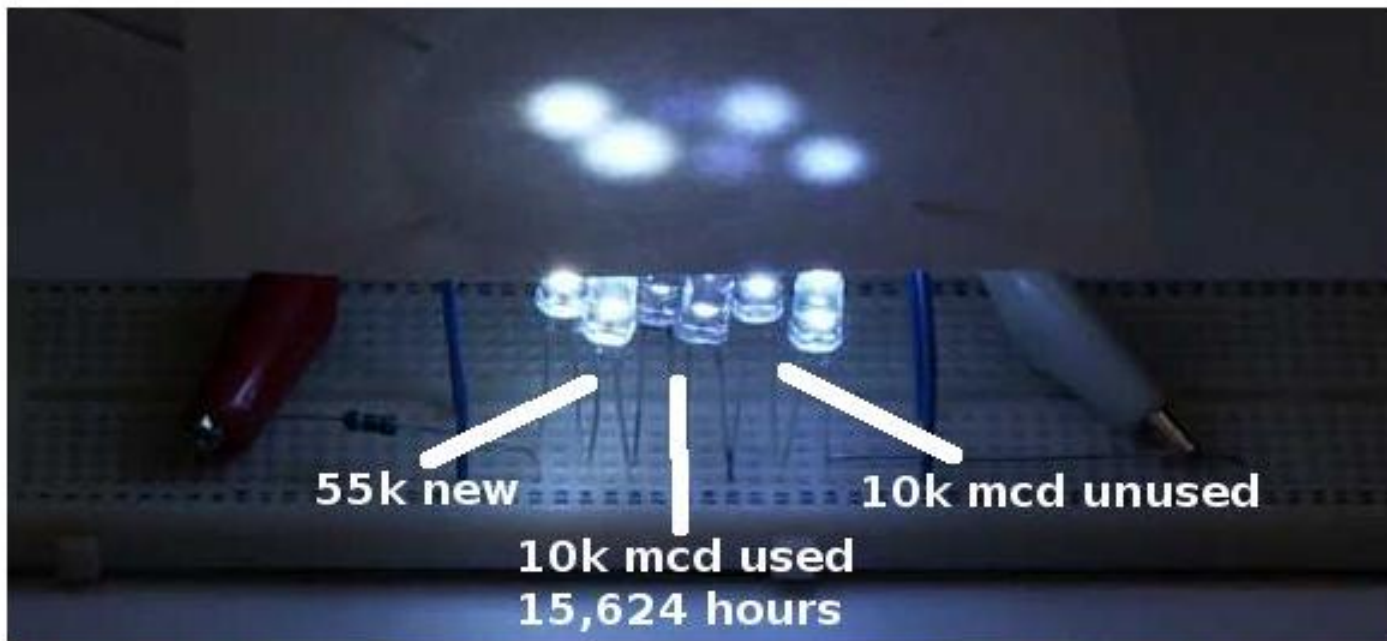


Coloured LED applications now abound- architectural and practical



White LED clusters have been revolutionary for personal night & inspection lighting

"100,000 hours" rated life for white LEDs may be too optimistic





Gradual failure of a white LED clock at Glasgow airport



White LEDs may be multiple clusters or (increasingly) single "Lumiled" power types



Moore's Law:

A 40 year old empirical observation that the transistor density of integrated circuits doubles every 18 months-2 years

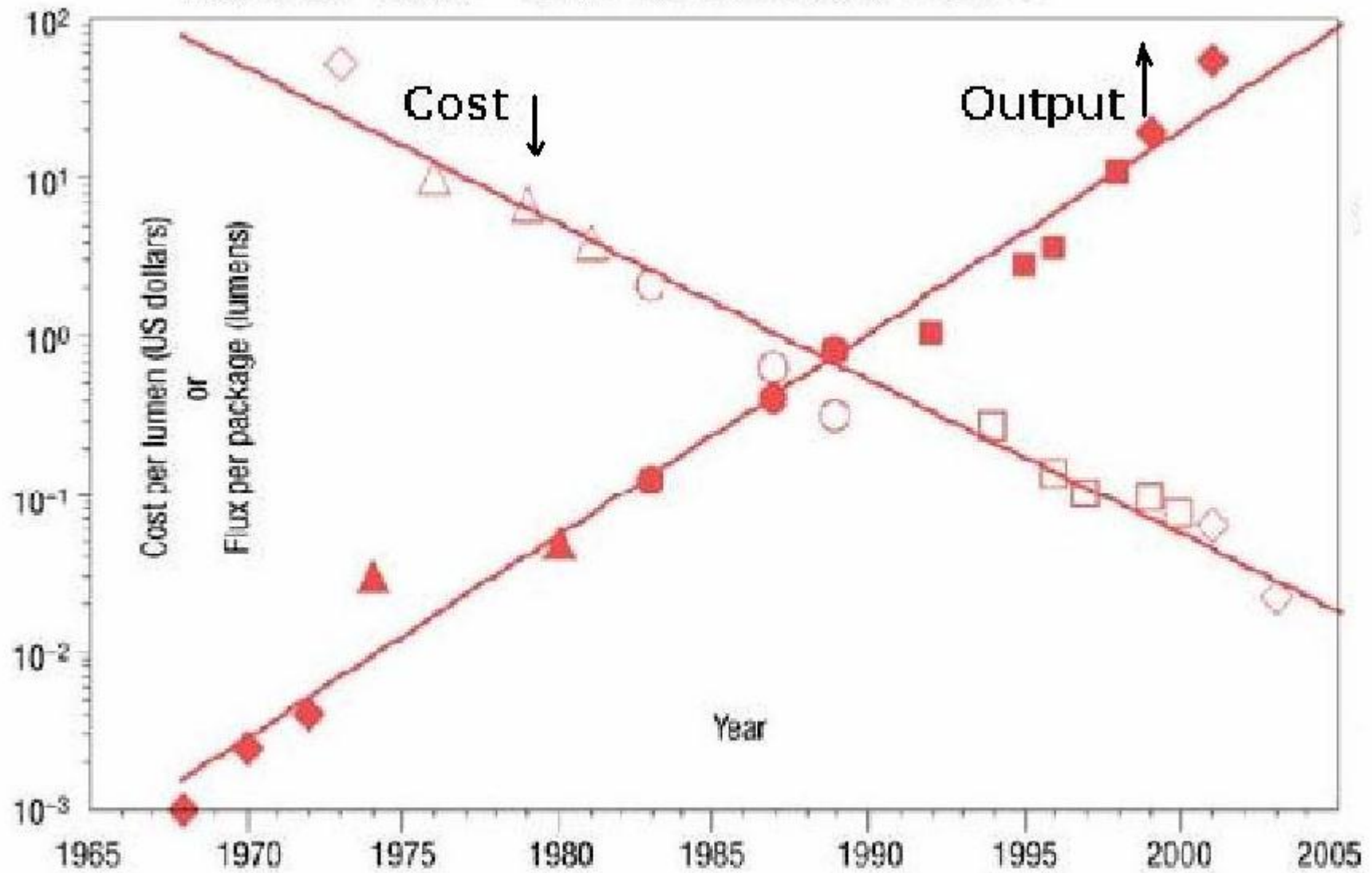
Haitz's Law:

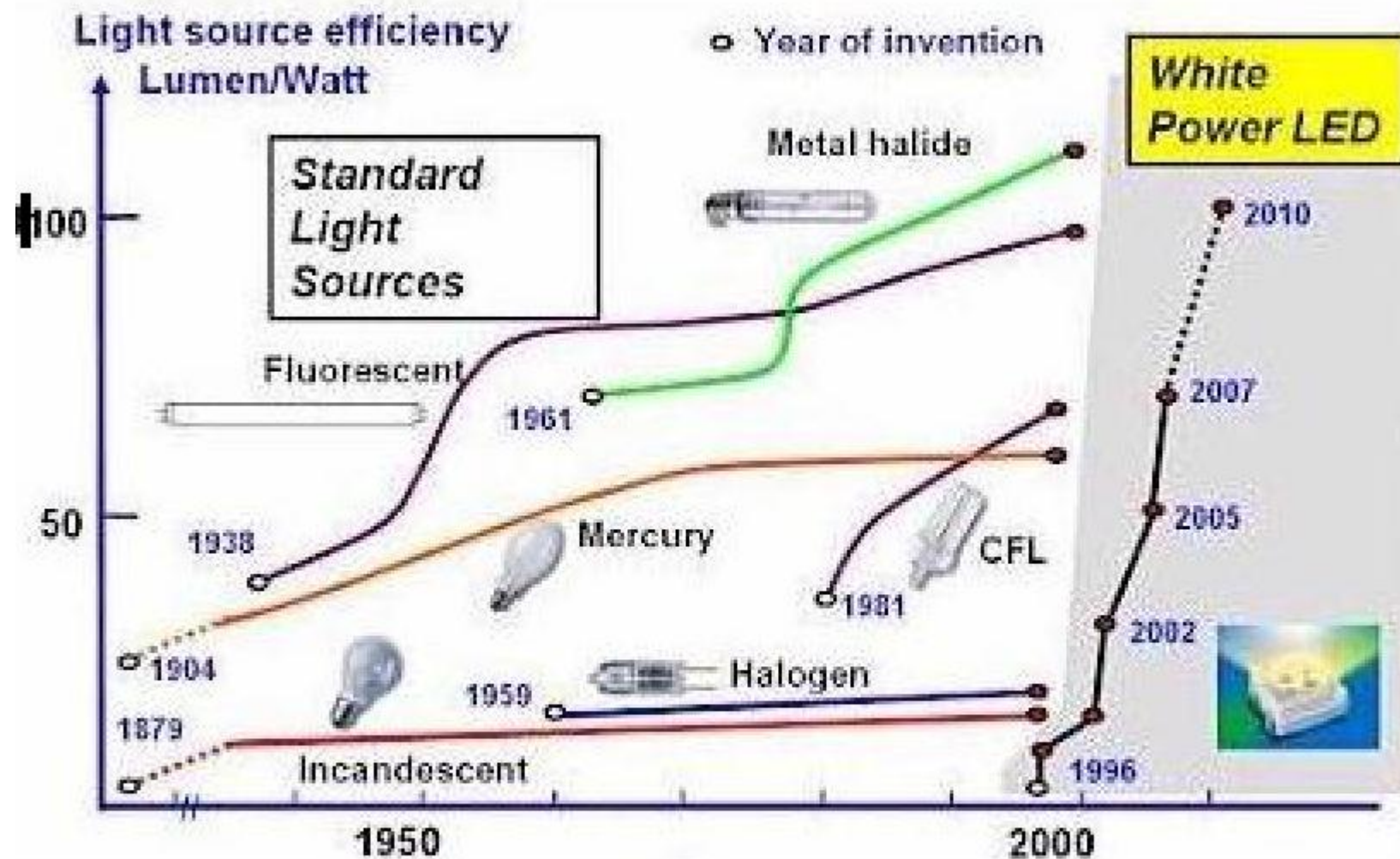
An observation that every decade - for a given colour of light -the cost per lumen (the unit of useful light emitted) falls by a factor of 10, & the amount of light generated per LED package rises by a factor of 20.



Both "laws" are now seen as somewhat conservative !

Haitz's Law - akin to Moore's Law !





**Comparative improvements
in light output**

Solar powered LED wall - Beijing



Conclusion:

If the present logarithmic Haitz's Law trends continue, LED lighting should become brighter and cheaper, meaning that in the next 5 years the following may be expected-

- LED based lighting the norm in new commercial buildings
- Domestic retro-fitting acceptance and cost effectiveness
- Lighting energy running cost reductions
- Improved reliability and cool running/fire safety benefits.
- The near obsolescence of both filament lamps and CFLs.
- Total automotive adoption, perhaps even for headlights.
- Architectural incorporation for public works and signage.
- "Wired daylight" consideration as a skylight alternative.

Stan. SWAN - Feb. 2010