Lighting: The Way of the Future

Effective/efficient/sustainable

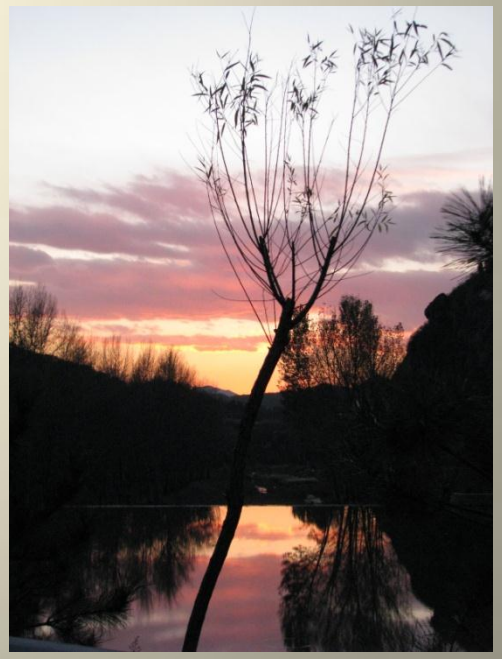
Steve Coyne

Why do we light?

To provide an amenable visual environment for people while enabling them to carry out the tasks at hand.

Any Secondary Issues?

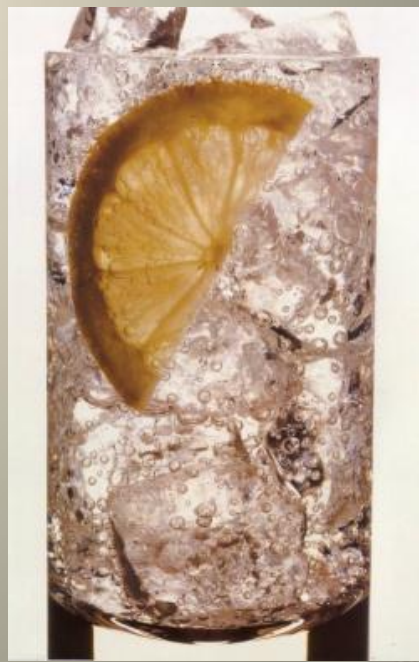
The creation of a lit space in the way which minimises its impact on the environment.



The Function of Lighting

Can be categorised into

- Safety / security
- People movement and task oriented
- Visual interest
- Highlight / Attract attention



Objectives of Lighting

To have sufficient lighting to achieve the function of the lighting

- When required
- As energy efficiently as possible, and
- In the most cost effective way

Efficient lighting

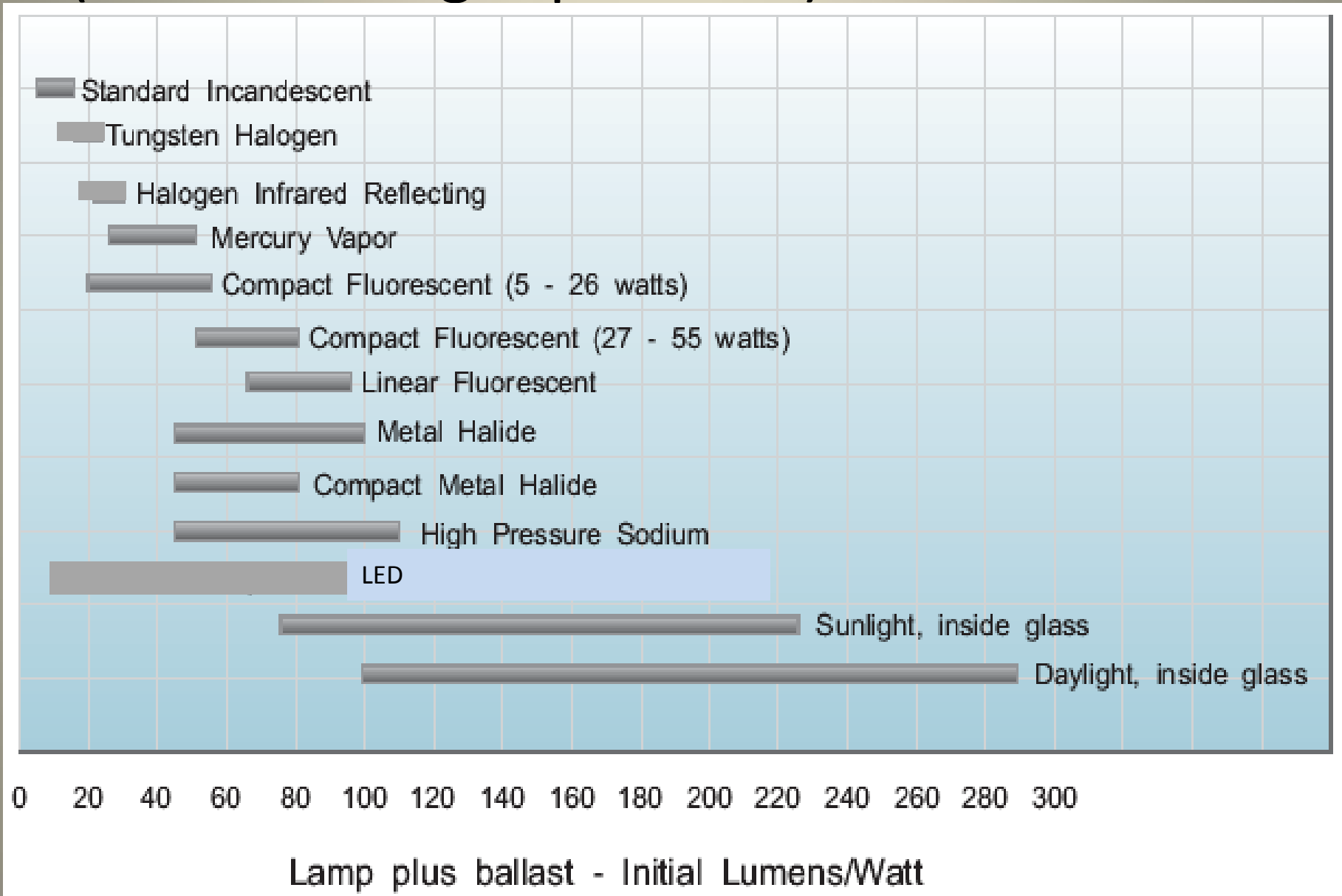
The Operational Energy Cost of Lighting

- Cost = Time x kilo Watts x price




- To reduce cost:
  - Limit time of operation
  - Reduce the power requirement
  - Shop around for a better price

Lamp Efficacy
(how much light per Watt)



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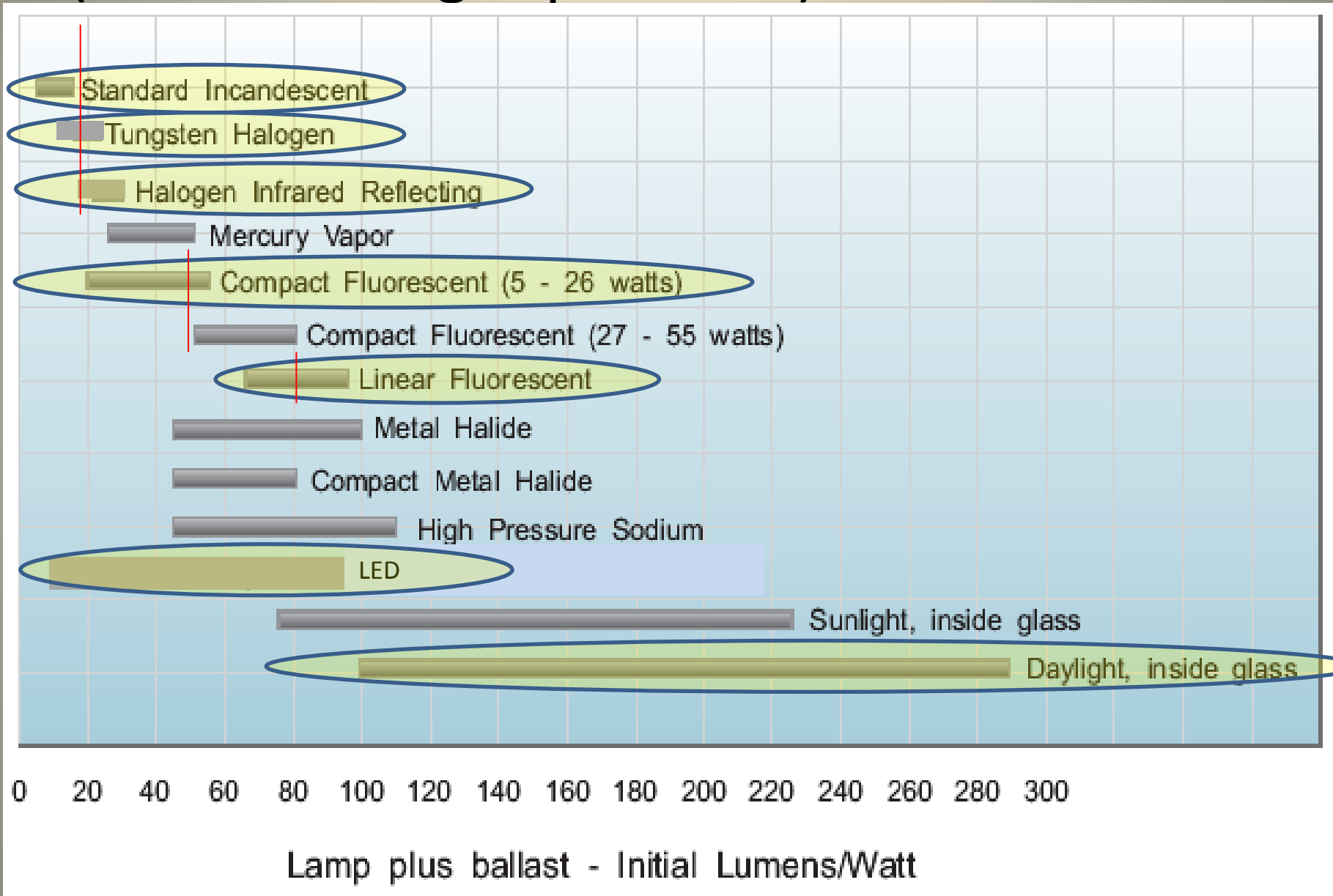
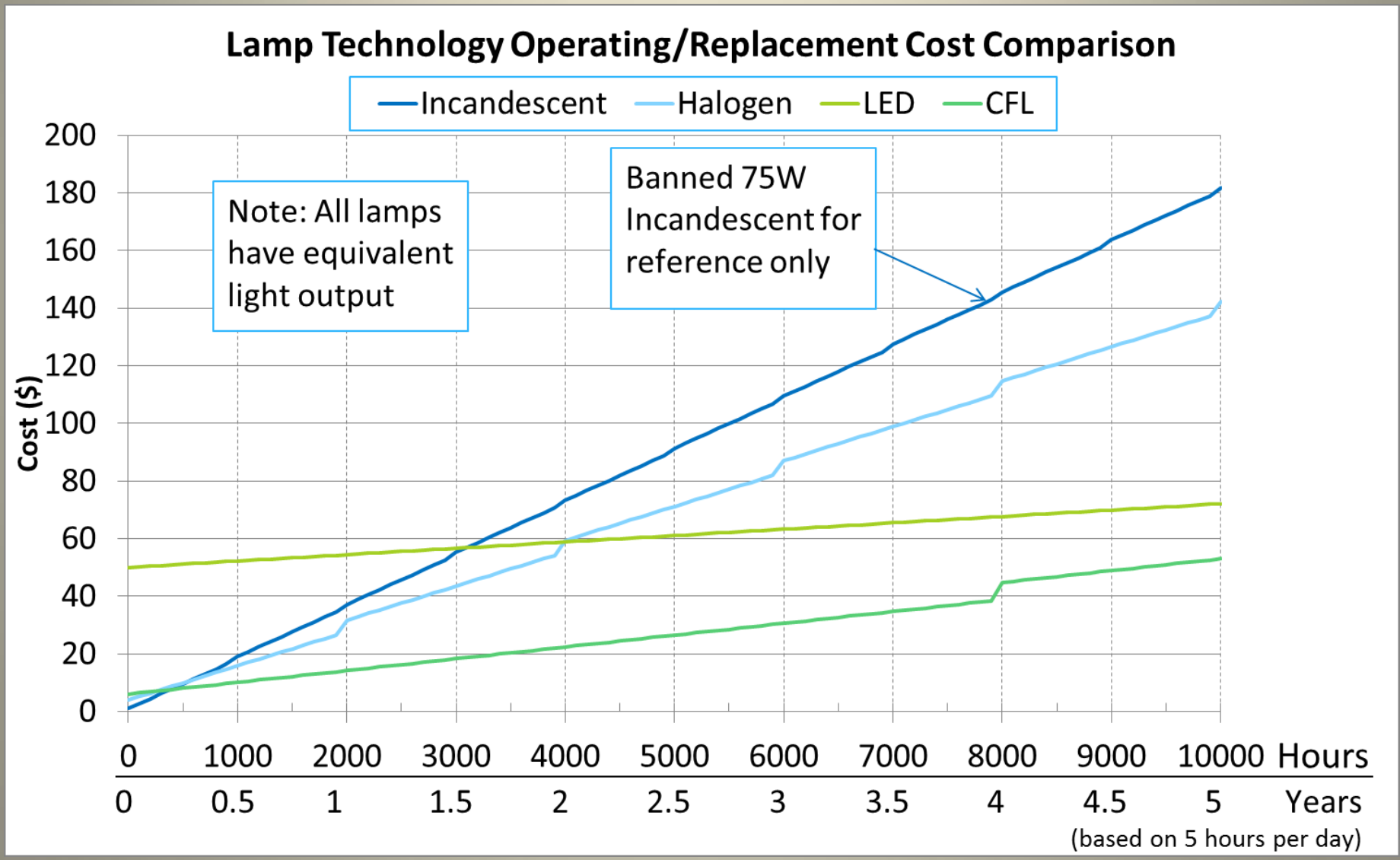


The Life of the Lamp
(impacts on replacement cost cycle)

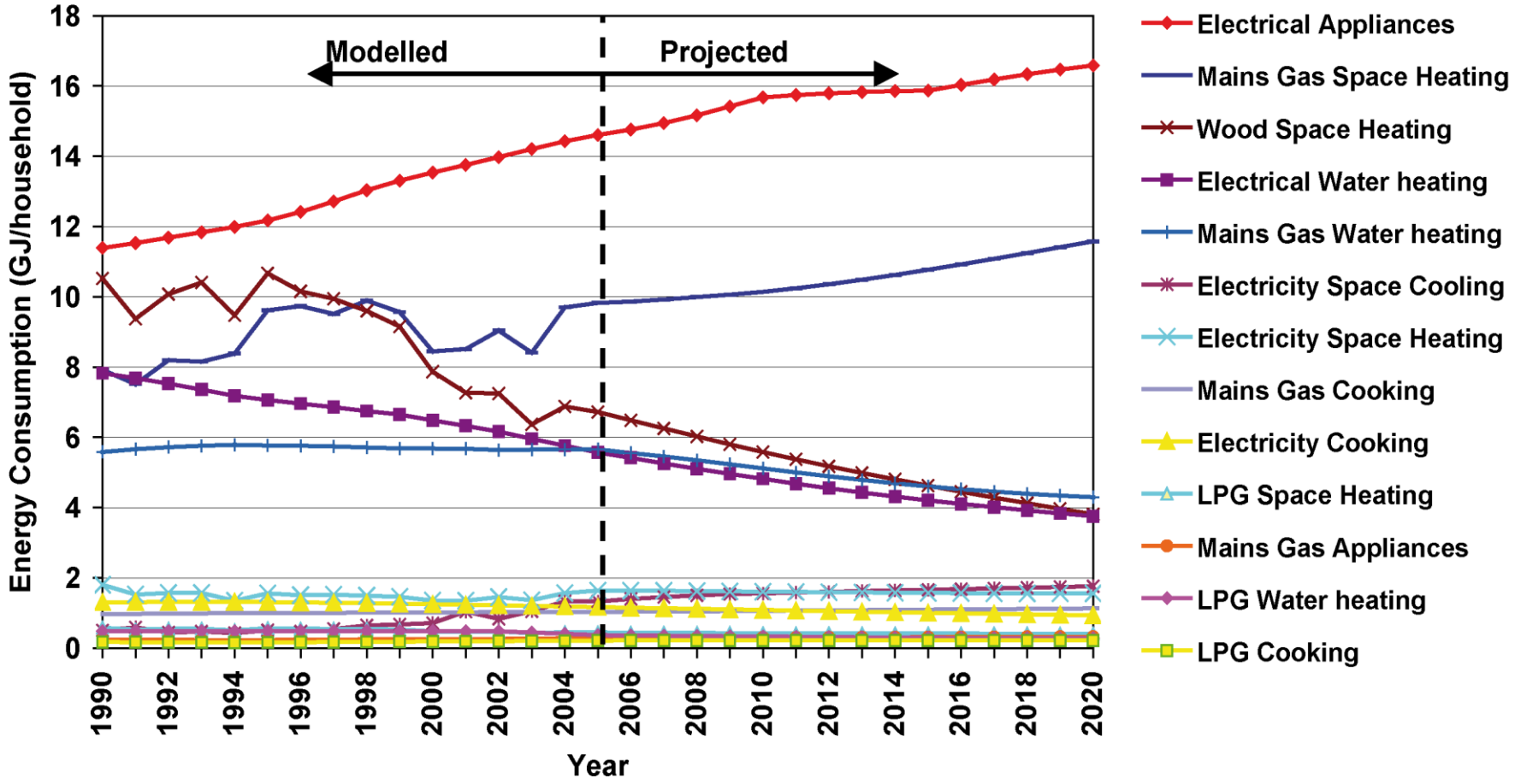
	Hours
• Daylight	35 000 000 000 000
• LED, Induction, (linear fluoro)	35 000
• Linear fluorescent, (CFL MH)	20 000
• CFL, Metal Halide	10 000
• Halogen (Dichroic)	2 000 (4 000)
• Incandescent (GLS)	1 000 (2 000)

Operation and replacement costs of lamps (labour not included)



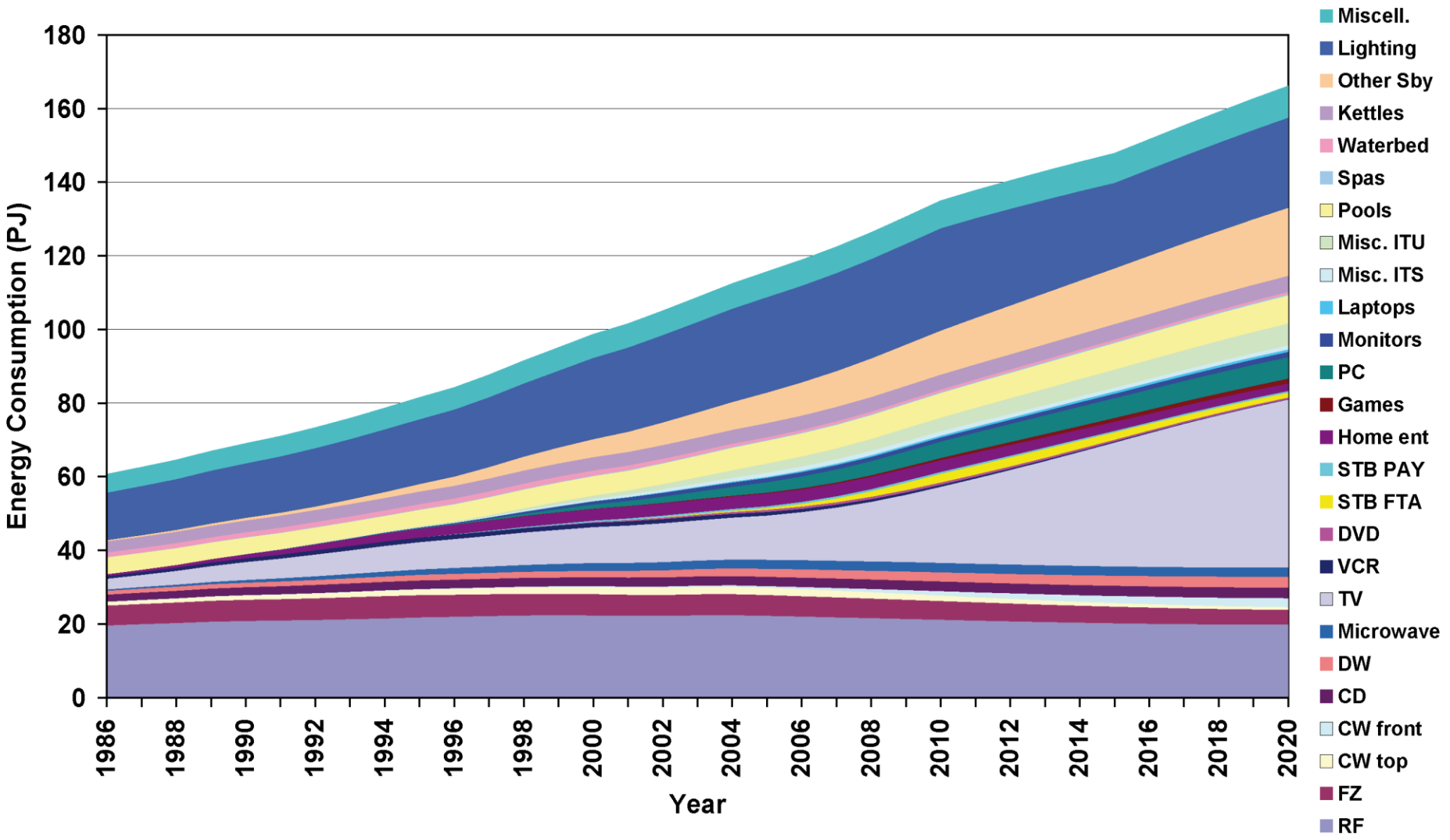
House energy use

Trends in Energy use per Household



Source: Energy Use in the Australian Residential Sector 1986 – 2020
http://energyrating.gov.au/library/details2008-energy-use-aust-res-sector.html

Trends in Energy – Electrical Appliances



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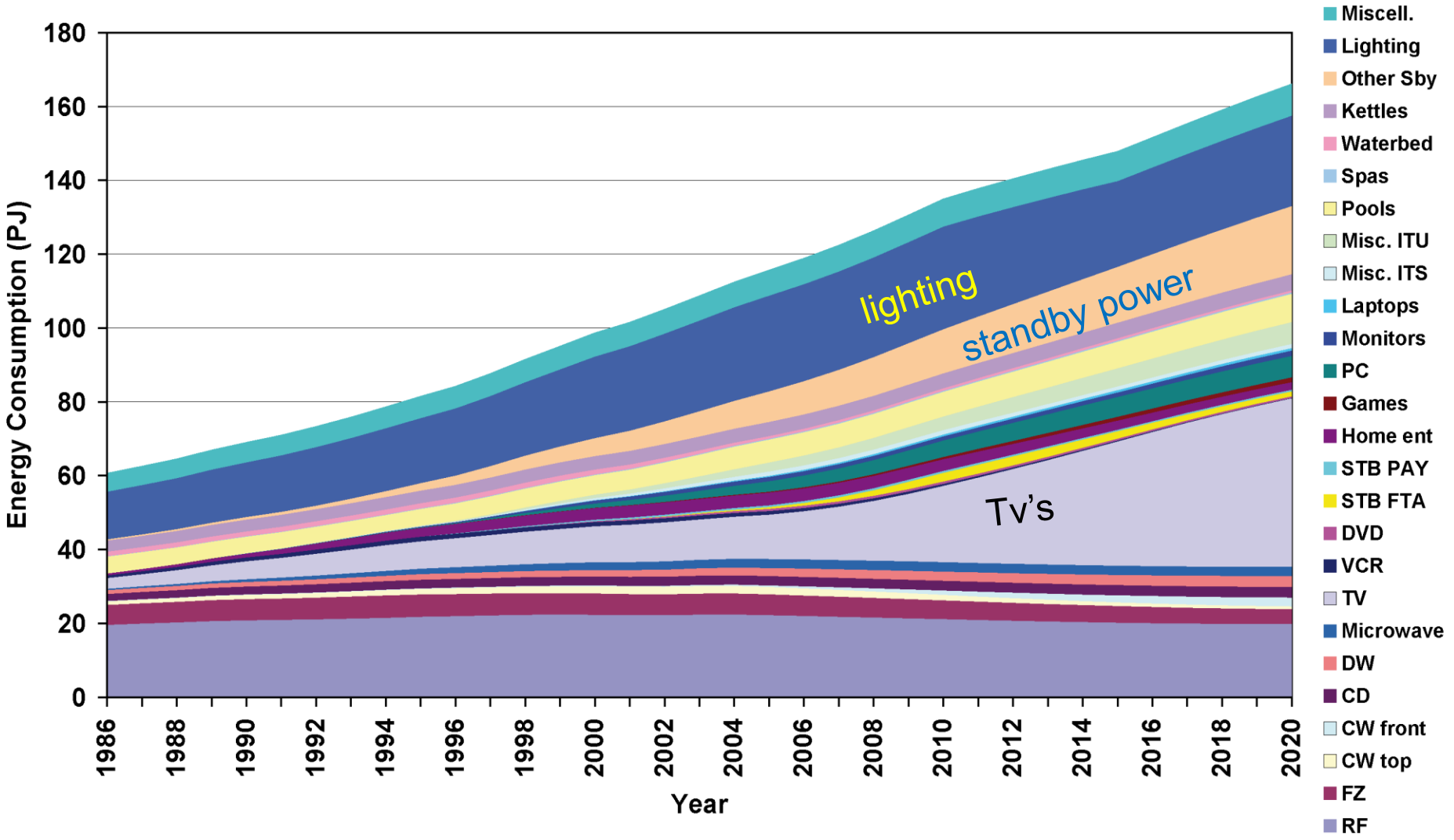

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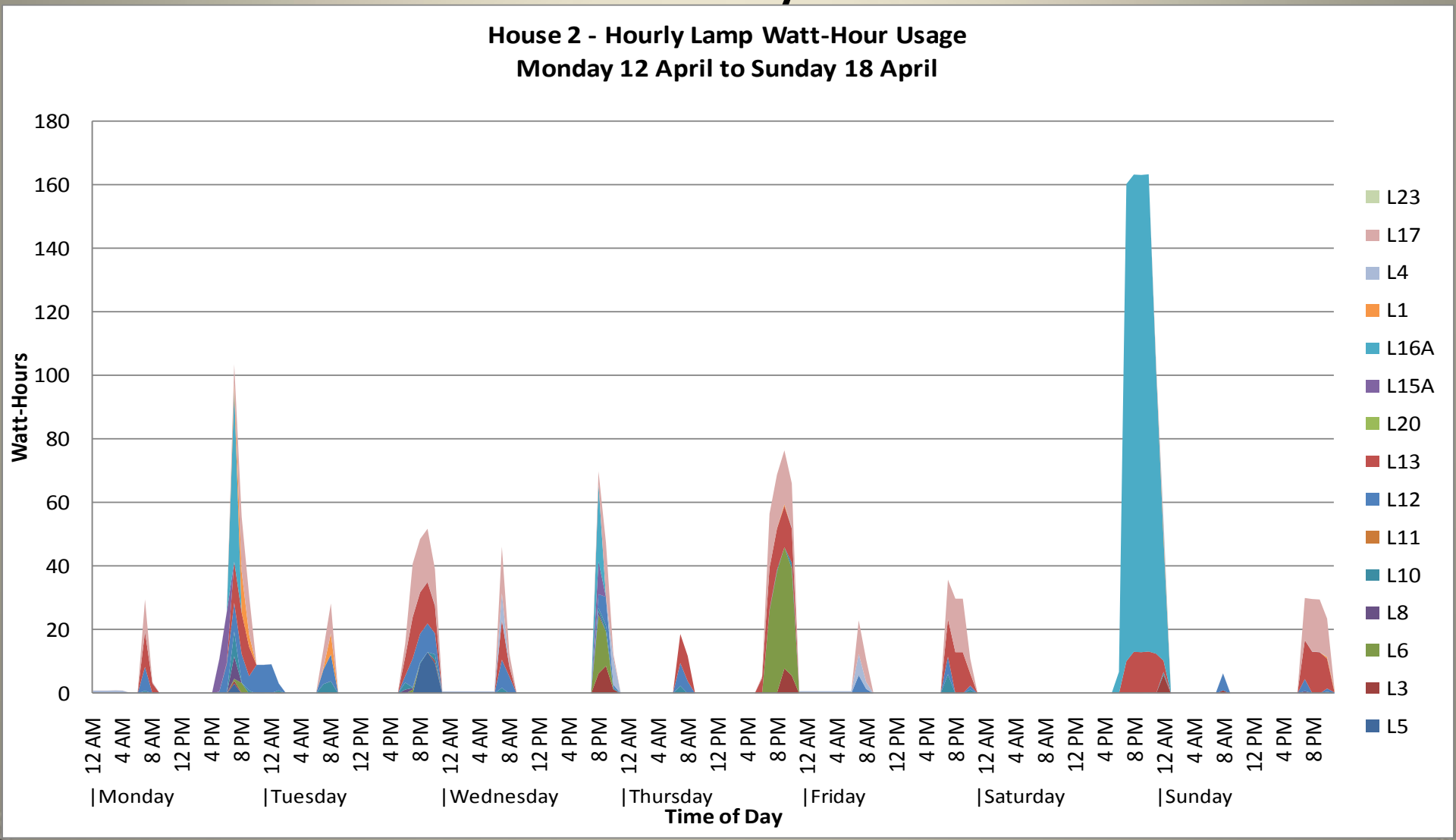
Dept Climate Change and Energy Efficiency
Residential Energy Monitoring Program
Pilot Study 2010



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Residential Energy Monitoring Program

Pilot Study 2010

Light	W.hrs	hrs	hrs / day	Room	no of lamps	Lamp Tech	Lamp W
L27	5,867	326	6.0	I-Hallway2	1	Compact fluorescent - integral ballast	18
L12A	8,618	319	5.9	I-Kitchen	3	Compact fluorescent - integral ballast	9
L26	2,320	224	4.1	I-Lounge	1	Compact fluorescent - integral ballast	10.36
L11B	15,199	211	3.9	I-Kitchen	2	Linear fluorescent	36
L16	15,669	209	3.9	I-Dining	1	Incandescent - mains voltage	75.06
L46	1,426	195	3.6	I-Bedroom4	1	Compact fluorescent - integral ballast	7.33
L21	2,317	168	3.1	I-Lounge	1	Compact fluorescent - integral ballast	13.81
L34	6,198	156	2.9	I-Bedroom3	1	Incandescent - mains voltage	39.8
L10A	12,711	127	2.4	I-Bathroom1	2	Halogen - low voltage	50
L22A	2,722	105	1.9	I-Lounge	2	Compact fluorescent - integral ballast	13
L40	6,002	100	1.9	I-Bathroom2	1	Incandescent - mains voltage	60
L25	898	86.7	1.6	I-Lounge	1	Compact fluorescent - integral ballast	10.36
L24A	3,078	59.2	1.1	I-Lounge	4	Compact fluorescent - integral ballast	13
L35	4,956	49.6	0.9	I-Hallway3	1	Incandescent - mains voltage	100
L7C	18,768	46.9	0.9	I-Hallway1	8	Halogen - low voltage	50
L45A	17,010	42.5	0.8	I-Bedroom4	8	Halogen - low voltage	50
L38A	1,656	15.3	0.3	I-Laundry	3	Linear fluorescent	36
L23A	2,006	10	0.2	I-Lounge	4	Halogen - low voltage	50
L6	-	0	0.0	I-Study	1	Incandescent - mains voltage	39.29

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The Big Picture

Sustainable lighting

International Emissions

- Incandescent lamps:
  - GHG emissions = 560 Mt p.a.[1]
- Switching to CFLs (or similar):
  - GHG emissions savings = 470 Mt p.a. [1]
  - Power stations not required = 38 [2]
  - Cars off the road = 118 million [3]
  - Trees planted per annum = 470 million [4]

1. International Energy Agency report, October 2006
2. 4 x 660MW power station, 90% availability
3. Estimated average car emits 4 tonnes CO2e p.a.
4. Estimated average tree sequesters 1 tonne CO2e over its lifetime

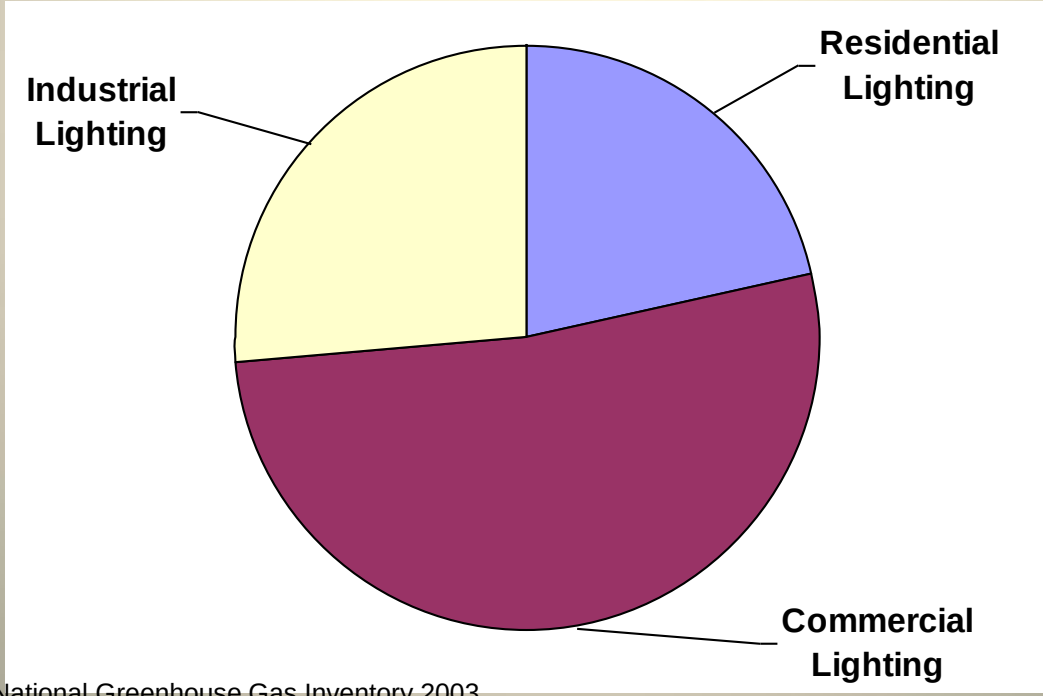
Context of Australian Emissions

- Incandescent lamps:
  - Approx 80 – 100 Million in Australia
  - GHG emissions = 6 Mt p.a. [1]
- Switching to CFLs:
  - GHG emissions savings = 4 Mt p.a. [1]
  - Cars off the road = 1 million [2]
  - Trees planted per annum = 4 million [3]

1. Modeling undertaken for Greenlight Australia Strategy
2. Estimated average car = 4 tonnes CO2e p.a.
3. Estimated average tree sequesters 1 tonne CO2e over its lifetime

Context of Australian Emissions

- 45 MT CO_2e p.a. from passenger cars [1]
- 25 MT CO_2e p.a. from lighting [2]



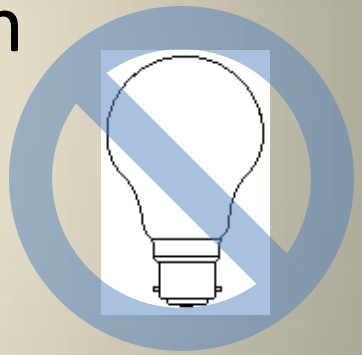
1. National Greenhouse Gas Inventory 2003
2. Modeling undertaken for Greenlight Australia Strategy

Regulation

Different Philosophies

What lamps are the Australian Government banning?

- Objective:
  - Eliminate inefficient lamps (eg incandescent) from the Australian marketplace
  - NOT technology specific
  - Must result in LOWER POWER lamps
    - Success will be measured by this



Phase-out Current situation

Ban on non-compliant:

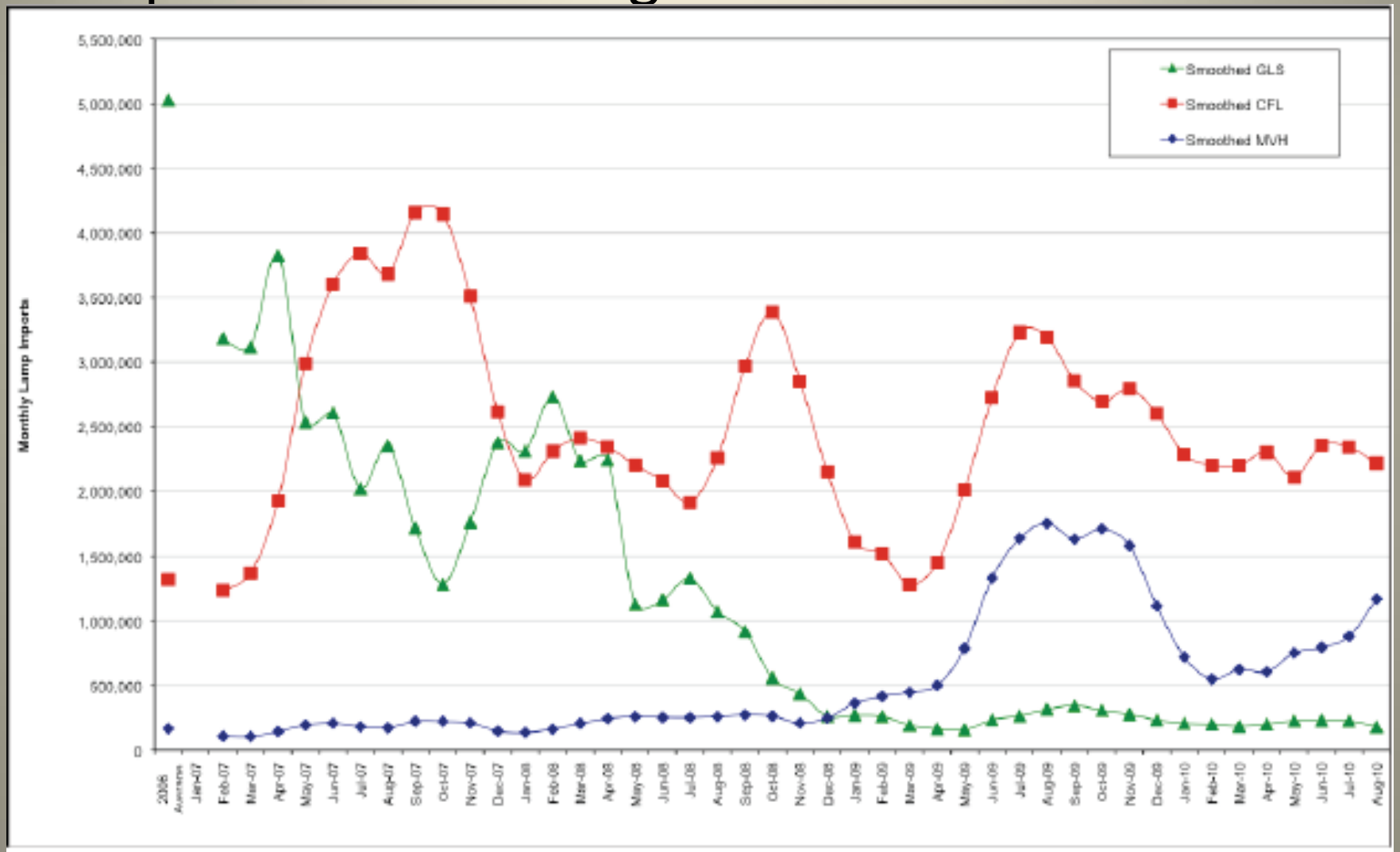
- Incandescent lamps

Also have efficiency performance requirements for:

- Compact fluorescent lamps
- Linear fluorescent lamps

Phase-out Current situation

- Imports reflect change



Phase-out Continues

- Retail ban on sale of non compliant products
- Currently includes:
  - candle-shaped, fancy rounds, etc > 40w
  - Mains voltage halogen non-reflector
  - ELV halogen reflector
- November 2011:
  - CFL reflector
- October 2012:
  - Mains voltage reflector lamps (PAR, R, ER, etc.)
  - candle-shaped, fancy rounds, etc > 25w.

BUILDING CODE OF AUSTRALIA

Classifications

- **Class 1a** — a single dwelling
- **Class 1b** — a boarding house, guest house, hostel or the like
- **Class 2** a building containing 2 or more sole-occupancy units each being a separate dwelling
- **Class 3**: a residential building, other than a building of Class 1 or 2
- **Class 10a**: a non habitable building being a private garage, carport, shed or the like

Deemed-to-Satisfy

The *Deemed-to-Satisfy* provisions are based on a maximum power density for different lighting tasks.

- Lamp Power Density (LPD)
- Illumination Power Density (IPD)

Volume 2 (Class 1 & 10)

3.12.5.5

Artificial lighting

(a) The *lamp power density* or *illumination power density* of artificial lighting, excluding heaters that emit light, must not exceed—

(i) in a Class 1 building, 5 W/m^2; and

(ii) on a verandah or balcony attached to a Class 1 building, 4 W/m^2; and

(iii) in a Class 10 building, 3 W/m^2, and

where *illumination power density* is used, it may be increased by dividing it by the *illumination power density* adjustment factor in Table 3.12.5.3 where applicable.

Volume 1 (Class 2 to 9)

Section J

J6.2

Artificial lighting

(a) In a *sole-occupancy unit* of a Class 2 building or a Class 4 part of a building—

(i) the *lamp power density* or *illumination power density* of artificial lighting must not exceed—

(A) within the building, 5 W/m^2; and

(B) on a verandah or balcony of the building 4 W/m^2; and ...

Advice for the Future

What should I consider when selecting a lamp?

- Purpose of light: ambient, task, highlight
- Directionality of light
- Priority ranking of performance parameters

Prioritise when selecting a lamp technology

Performance parameter	Priority	Lamp technology		
	H / M / L	A	B	C
Maintenance (Lamp life)				
Dimmability				
Startup (and re-strike) time				
Ambient temperature range				
Efficacy				
Lumen Package (per lamp)				
Colour rendering (light quality)				
Depreciation (output at end of life)				
Replacement components				
Cost per lamp				
Installation Costs				
Perception (visual significance)				

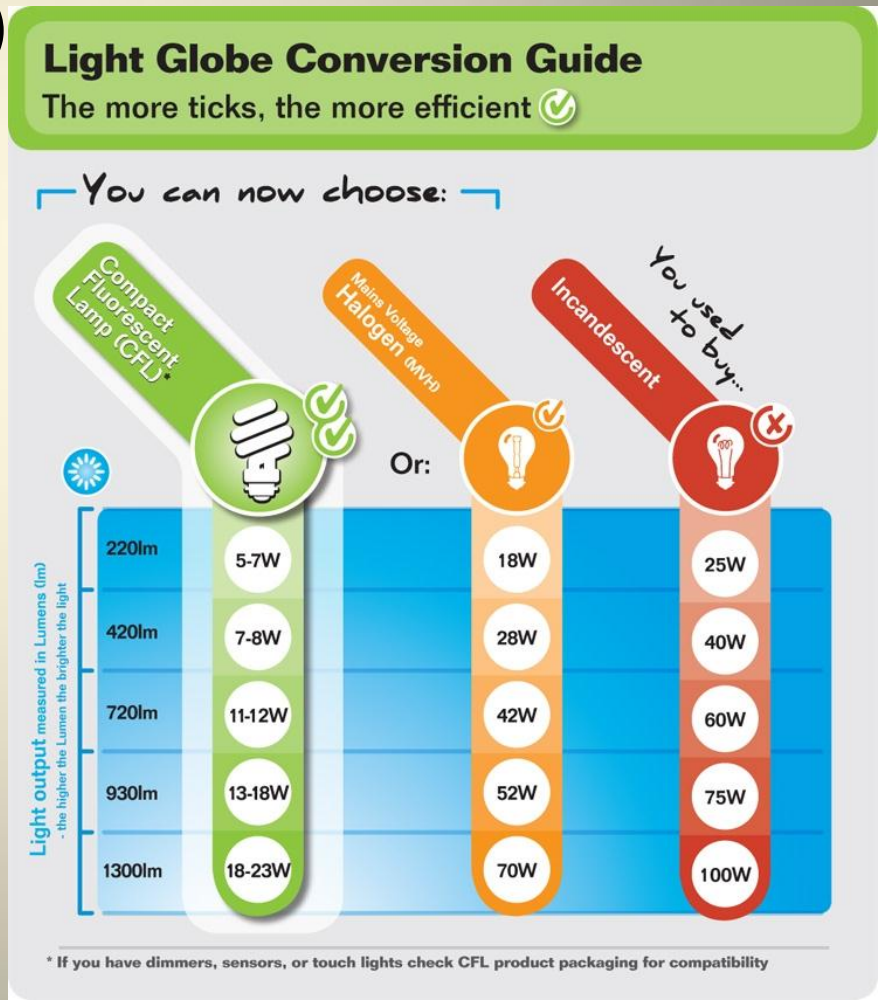
What lamp power is equivalent to an existing incandescent lamp ?

Equivalence of light output (like for like)

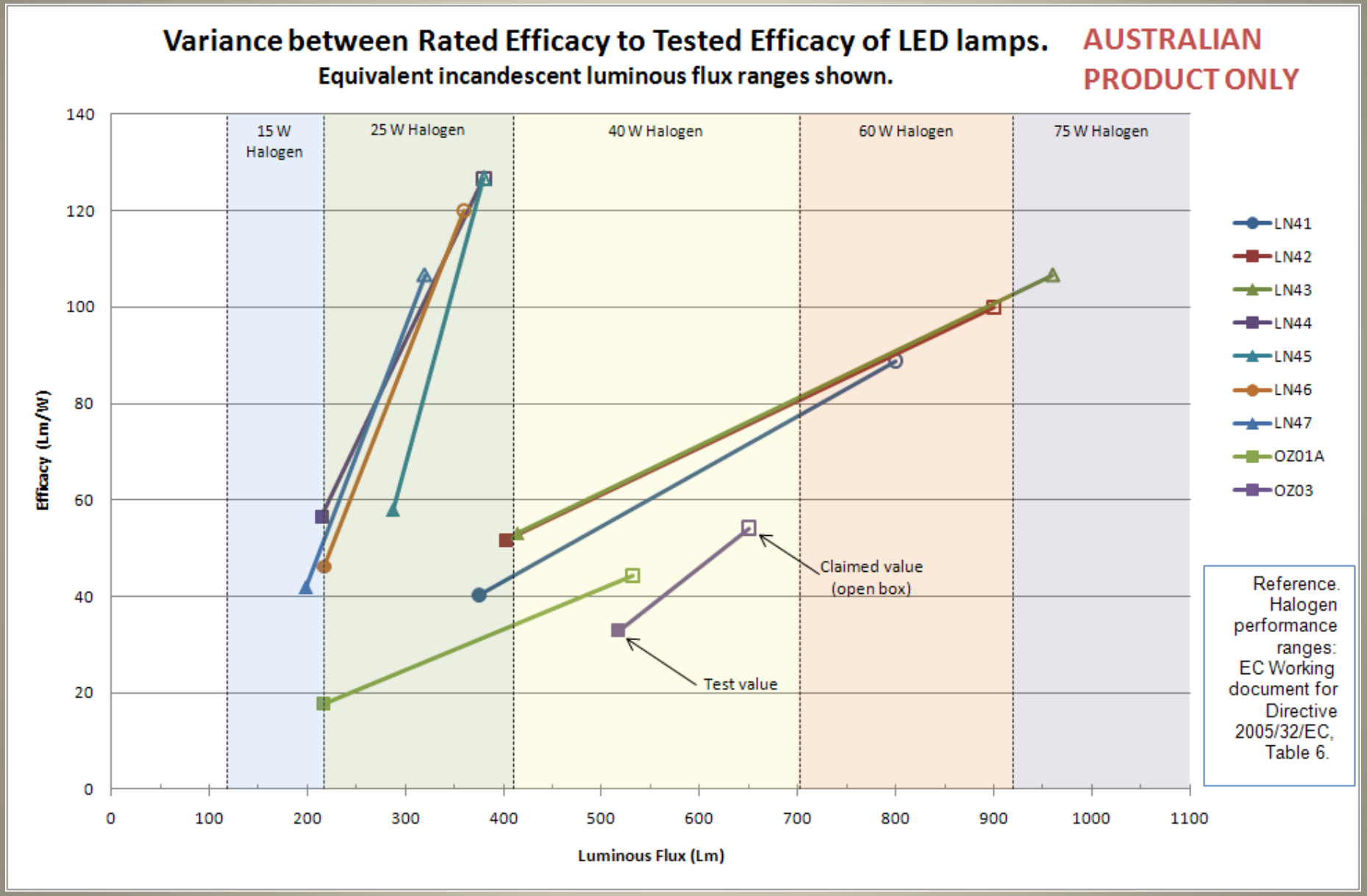
- Incandescent Watts =
  - Average LED Watts x 6
  - Good LED Watts x 9
  - CFL Watts x 5
  - TH Watts x 1.4

- This varies between manufacturers

- Need to question whether original Incandescent was over lighting.



LED products – Truth in Claim?



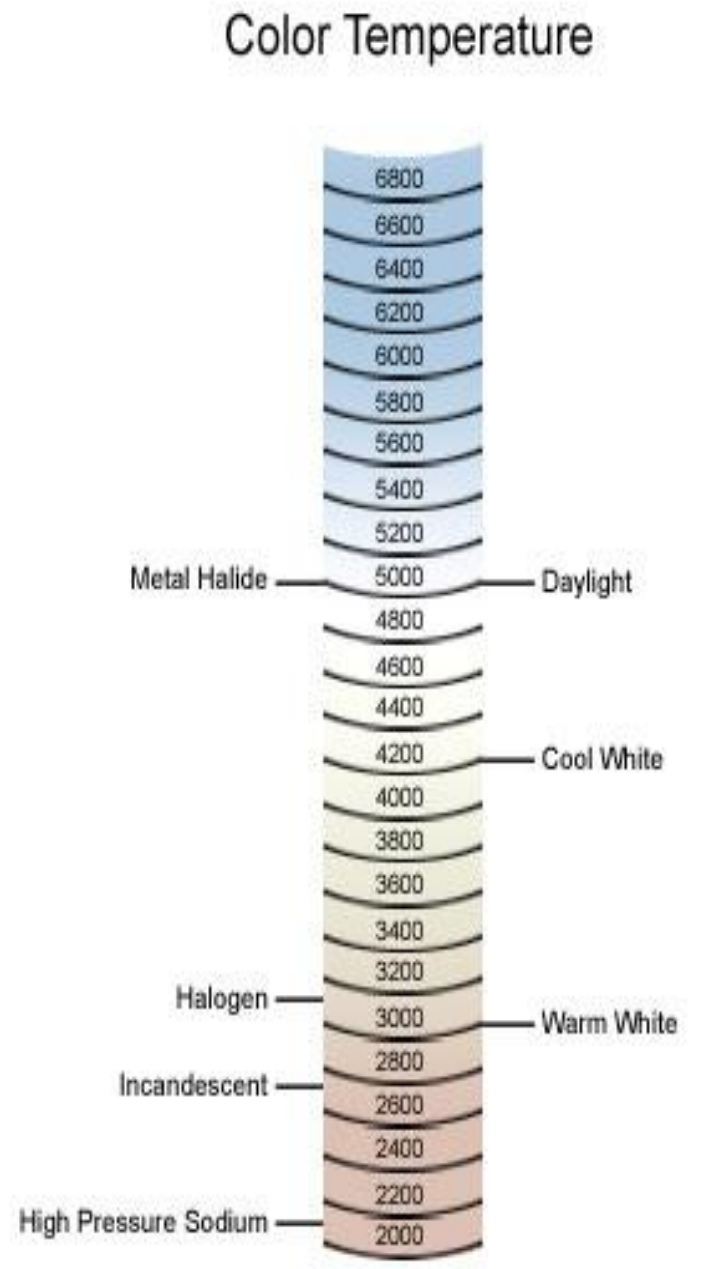
Dept of Climate Change & Energy Efficiency www.energyrating.gov.au/2010-11ledlighting.html

What do the different colours mean?

- Colour of CFL's and LED's vary (similar to standard fluorescent tubes)
- Classified as

Warm White
White
Cool White
Daylight

- Warm white is a fairly good match for incandescents



Source: http://www.lightbulbsdirect.com/page/001/CTGY/ColorTemp

Is there any reason for choosing different sizes or shapes?

- Choose based on:
  - Ability to fit into existing fixture
  - Décor
  - Your preference

Do CFLs contain mercury?

- CFLs contain a very small amount of mercury sealed within the glass tubing
  - an average of 3 - 5 milligrams,
  - roughly equivalent to an amount that would cover the tip of a ball-point pen.
- No mercury is released when the bulbs are intact or in use.
- Many manufacturers taken significant steps to reduce mercury in fluorescent lighting products.
- Recycling on increase (www.fluorocycle.org.au)

More CFLs – more mercury?

- Utility power plants (mainly coal-fired) are the largest man-made source
  - mercury that naturally exists in coal is released into the air when coal is burned to make electricity.

- CFLs (and LEDs) present an opportunity to reduce mercury emissions from entering the environment
  - by using 80% less electricity than incandescent lamps
  - reduce emissions from coal-fired power plants.

Rules of thumb

- Directional lamps
  - Halogen (dichroic)
  - LED
  - Some non-directional lamps with quality optics in fixture
- Non directional lamps
  - Fluorescent (CFL, circular, linear)
  - Halogen “look-a-likes”
  - Induction
  - Metal halide

Take a “horses for courses” approach to selection of lamp types and sizes

Dimmability

- Some CFLs are compatible with existing dimmers
  - only dim to about 10%
  - Not low enough for some applications
- Many LEDs are promoted as compatible with existing dimmers (check recommended lists)
- All Halogens are dimmable

So what's good practice?

- Natural lighting but limiting glare
- Limit depth of rooms away from window walls (no more than 3.5 x window height)
- Skylights in single storey houses with deep or core spaces (or internal stair wells of 2 storey)
- Horses for courses in terms of lamp types and sizes
- You only pay when they are turned ON.

Top 10 Lighting Tips

1. Think about what you want your lighting to do – focus on the application, not the light
2. Match the light source with the application
3. Let your eyes be the guide when it comes to lamp colour
4. Check light fittings for functionality and spare parts before you buy
5. Build controls into your lighting to enhance flexibility

Top 10 Lighting Tips

6. Work with daylight, rather than fighting it
7. Don’t be afraid of the dark, it can be used to create effect
8. Consider location and type of light fittings for ease of maintenance
9. Make sure retrofit lamps fit completely in the fixture & replacement components are available
10. Warranties should be commensurate with claimed lifetime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Unsure?

- Ask a qualified lighting professional.
- A Member of the Illuminating Engineering Society of Australia and New Zealand

www.iesanz.org/resources/services-products-directory/

Reference Material

- The Basics of Efficient Lighting handbook

www.energyrating.gov.au/resources/program-publications/?viewPublicationID=1486

- www.sustainable-homes.org.au

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