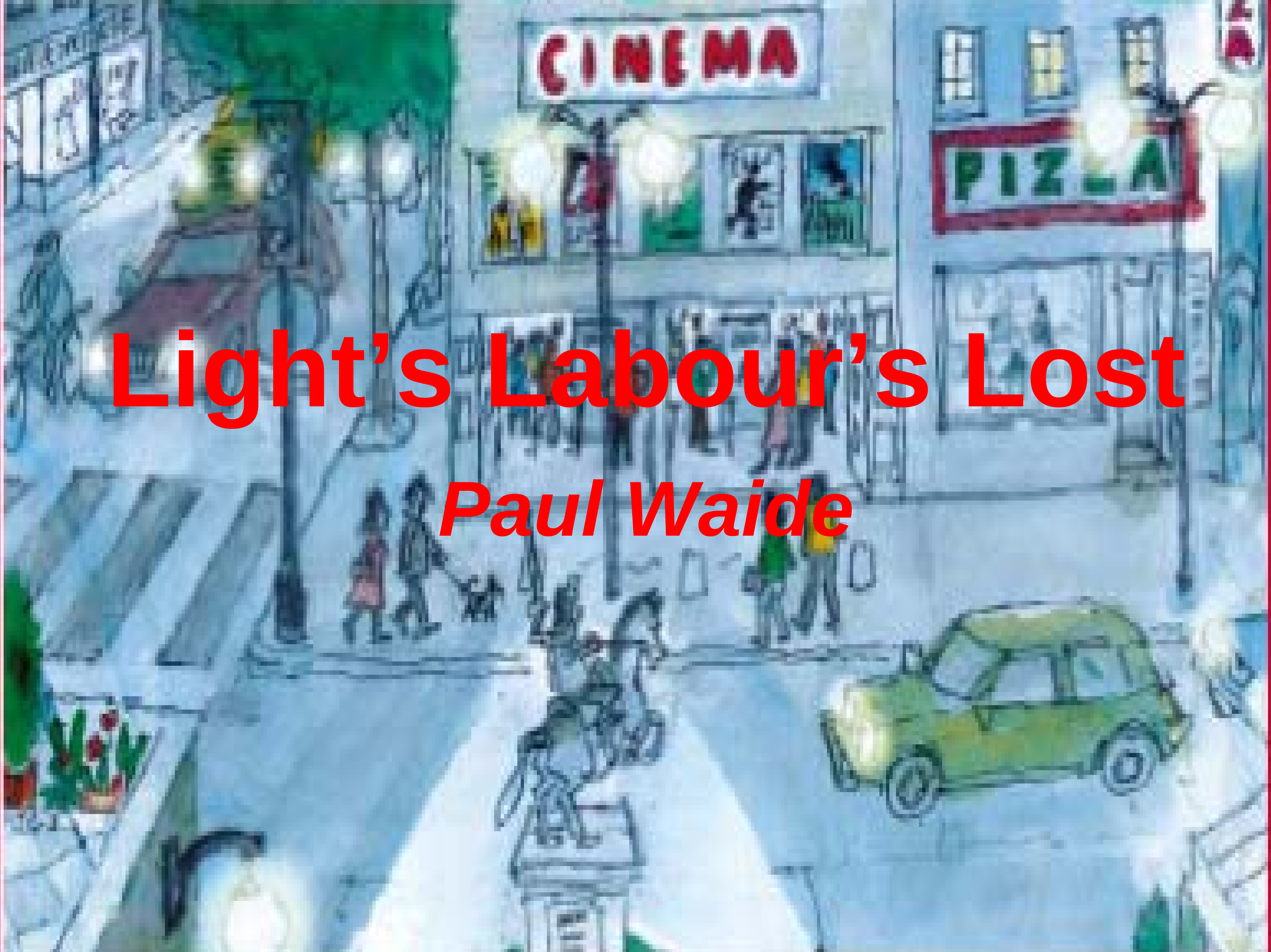
Light's Labour's Lost

Paul Waide



Love's Labour's Lost

A play by Mr William Shakespeare

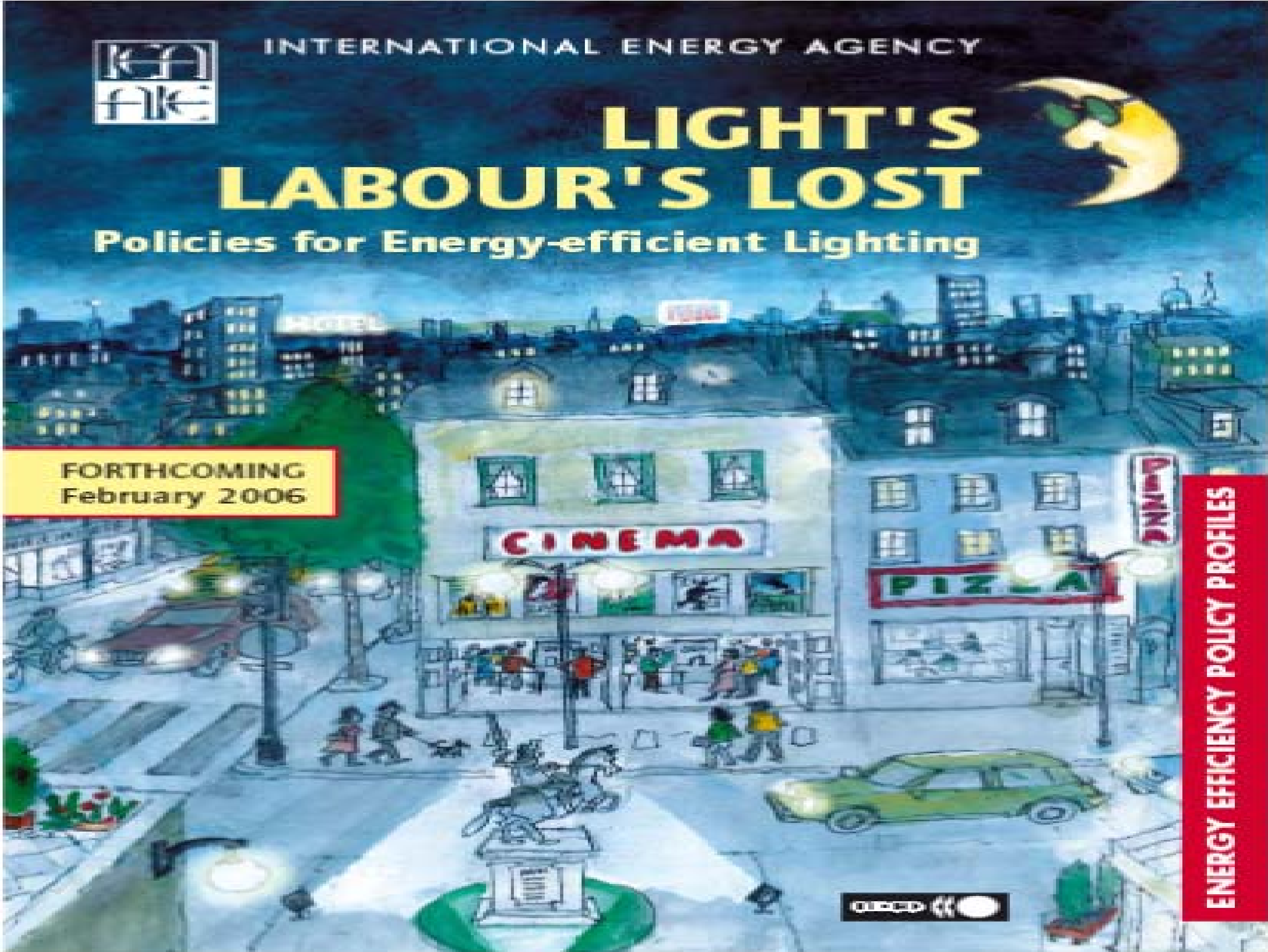
INTERNATIONAL ENERGY AGENCY

LIGHT'S LABOUR'S LOST

Policies for Energy-efficient Lighting

FORTHCOMING
February 2006

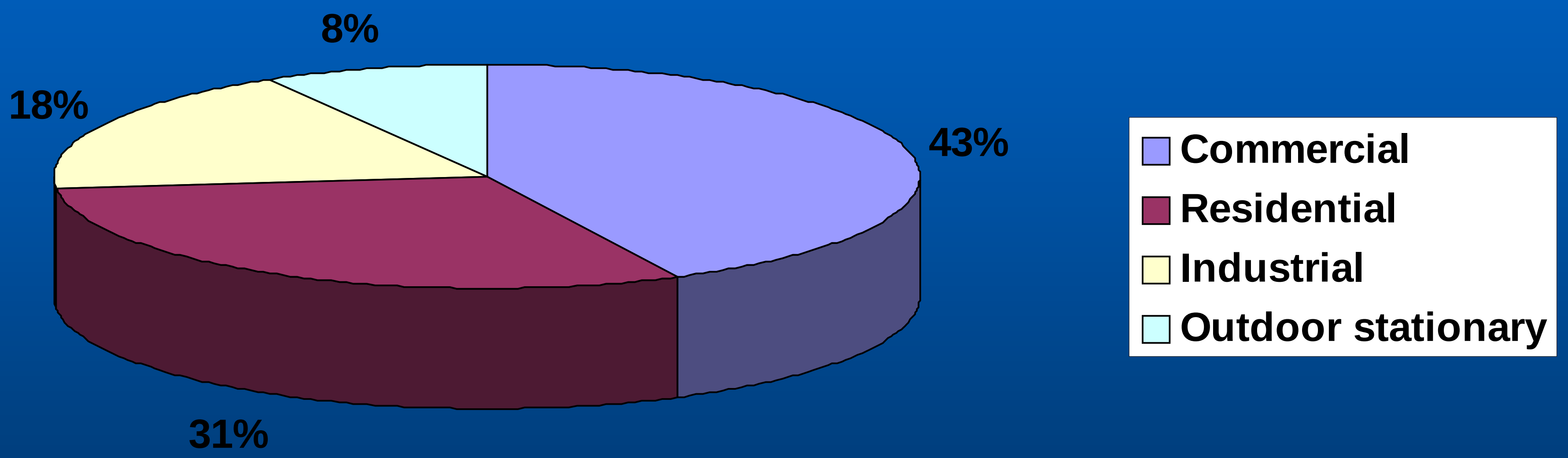
ENERGY EFFICIENCY POLICY PROFILES



How important is lighting?

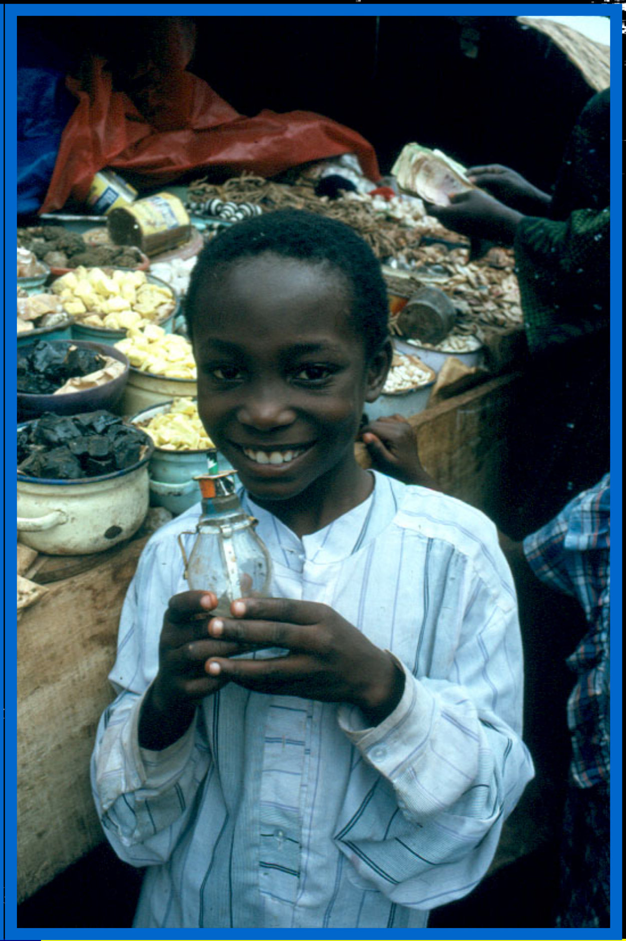
- 650 Mtoe of primary energy consumption
- 2550 TWh of electricity consumption
- 19% of global electricity use
- 15-17% greater than nuclear or hydro power
- Equivalent to production of all gas-fired power generation or 1265 power plants

Lighting electricity consumption shares by sector in 2005



Fuel-based lighting

- 1.6 billion people use fuel for lighting



Energy used by off-grid domestic fuel-based lighting in 2005

- 77 billion litres of kerosene (parafin) and gasoline/diesel used by fuel-based lighting
- 1.3 million barrels of oil a day
- Large health implications – respiratory diseases, heart failure, eyestrain
- Large economic implications – expensive and very low productivity

Energy used by vehicle lighting in 2005

- 55 billion litres of gasoline/diesel used to power vehicle lights
- 1.1 million barrels of oil a day
- 3.2% of global vehicle energy use
- Xenon-arc lamps use 20% of the energy of halogen headlamps for same light output
- Red LEDs much more efficient than incandescent lamps for CHMSLs

Cost of lighting in 2005

- Total cost of non-mobile electric lighting is US$356 billion (US$2.8/Mlm-hr)
- Equivalent to 1% of global GDP or the total GDP of the EU-10
- US$238 billion energy-cost non-mobile electric-lighting (two thirds)
- Fuel for domestic fuel-based lighting costs US$38 billion each year

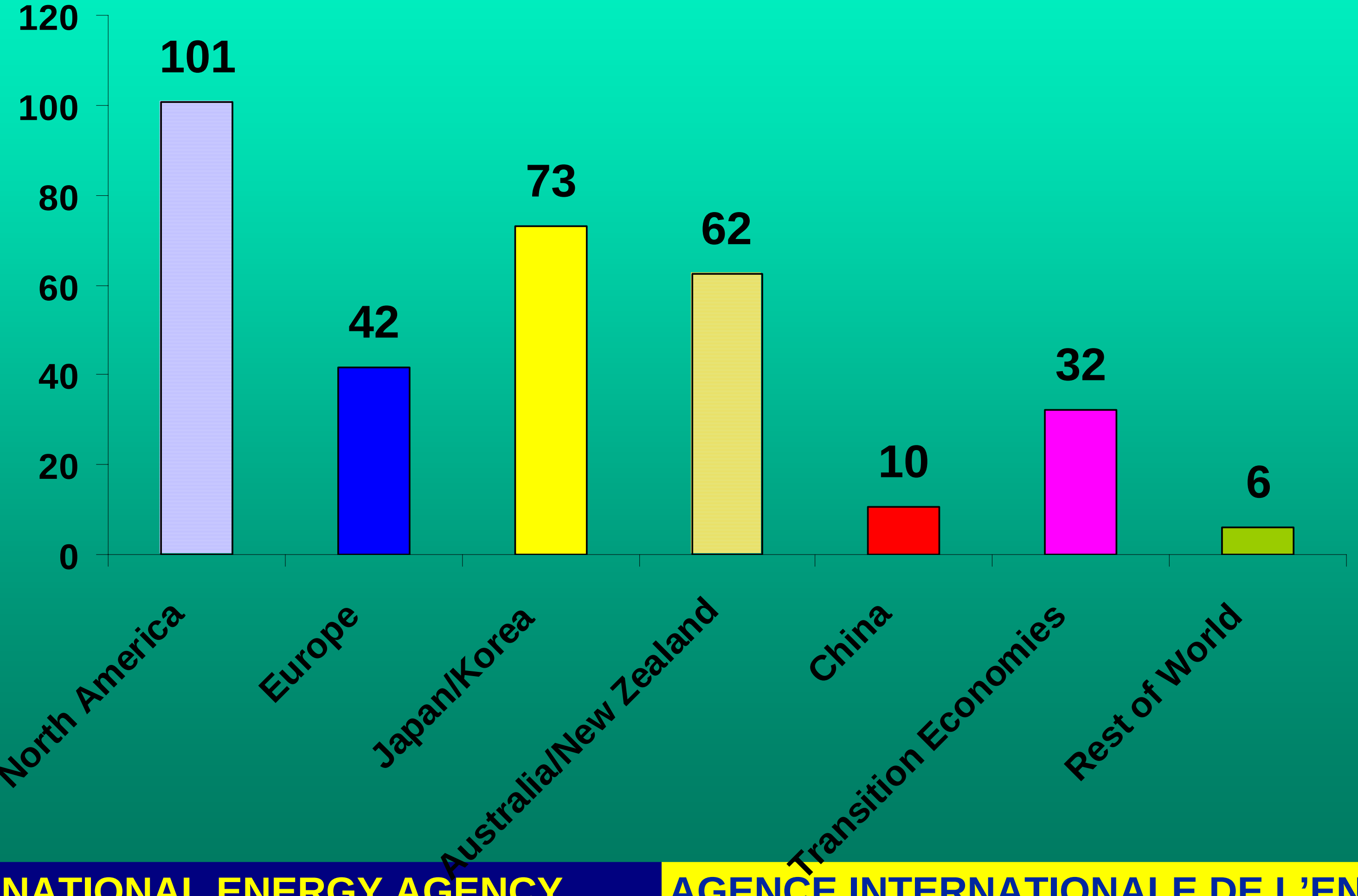
Lighting CO_2 emissions in 2005

- All lighting = 1889 $MtCO_2$
  - Grid based = 1528 $MtCO_2$
  - Fuel-based lighting = 200 $MtCO_2$
  - Vehicle lighting = 161 $MtCO_2$
- Equivalent to 70% of world passenger vehicle emissions

Artificial source lumens: 2005

- Global average consumption of 20 Mega-lumens of light per capita/year
- Average North American uses 101 Mega-lm-hrs; average Indian 3 Mega-lm-hrs
- But that's still 600 times average artificial per capita light use in England in C19th
- Global light consumption = 127 Peta-lm-hrs in 2005

Average per capita electric light consumption (Mega-lumen-hrs per person/year)



Recommended illumination levels vary

- Today nationally recommended levels in offices range from 200 to 1500 lux!

Table 18: Recommended illuminance levels in 6 EU countries

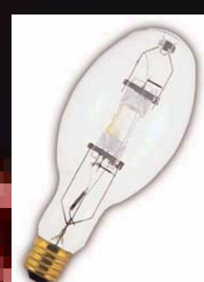
Which illuminance levels are recommended for the different categories?						
	Belgium	Denmark	Greece	Italy	Spain ¤	UK
Office - general lighting	200	50-200	500	500	300-700	500
Office - task lighting	500	200/500 £	500	750 *	500-1000	300-500
Educational - classroom	200	200	300	500	300	300
Educational - blackboard	500	200/500 £	400	500	500	500
Health care ward - general	200	50/200 @	30-50 &	500	100-200	30-50
Health care ward -task	500	500	150	750 *	500	100
Shops general lighting	200	50-100 §	300	200	500-1000	500-1000 #
Shops - task - cash desk	500	500	500	300 *	1500-3000	500-1000 #

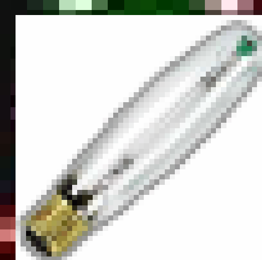
"These lovely lamps, these windows of the soul."

- Incandescent

- Fluorescent

- HID





Large differences in lamp efficacy

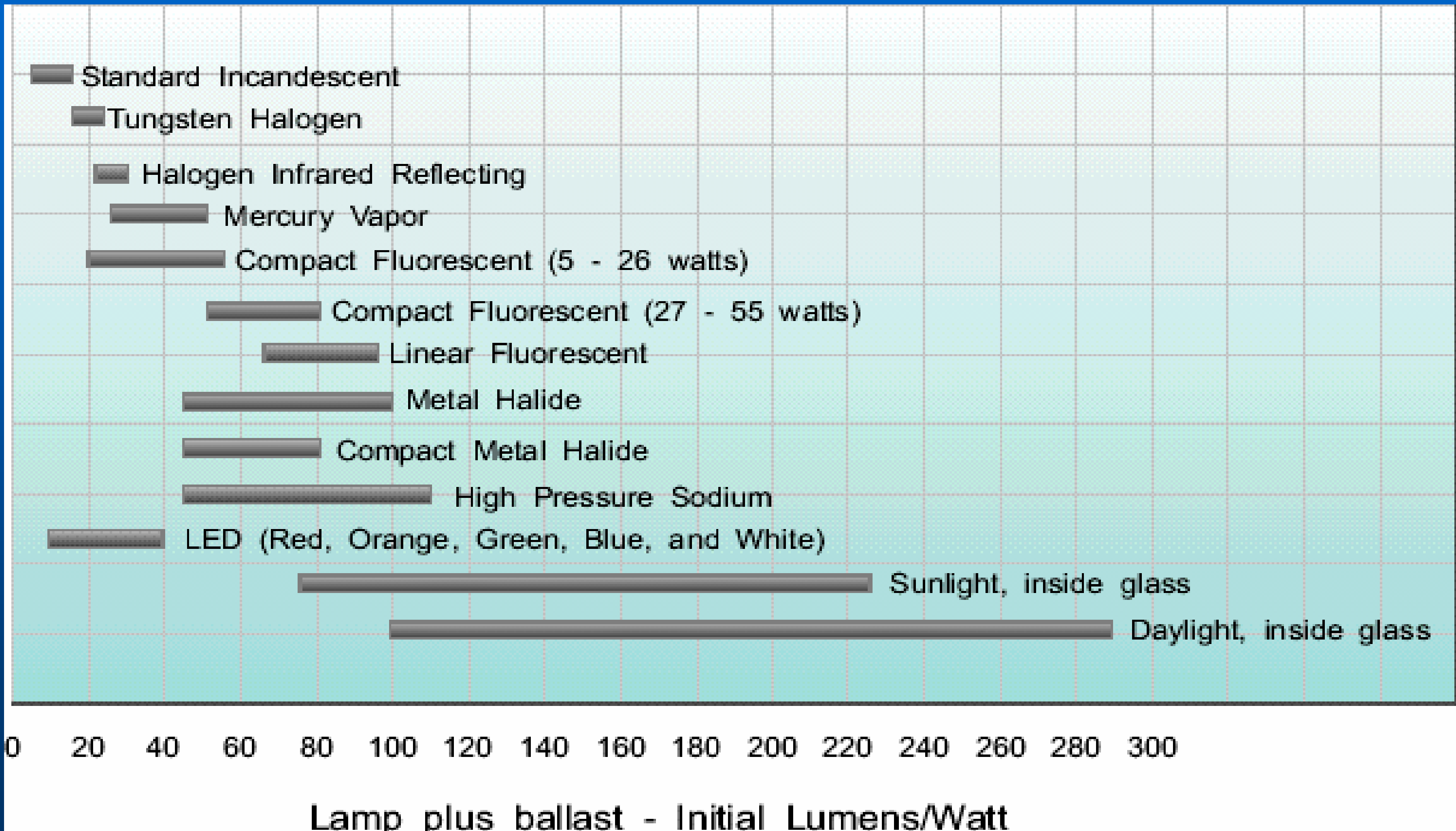


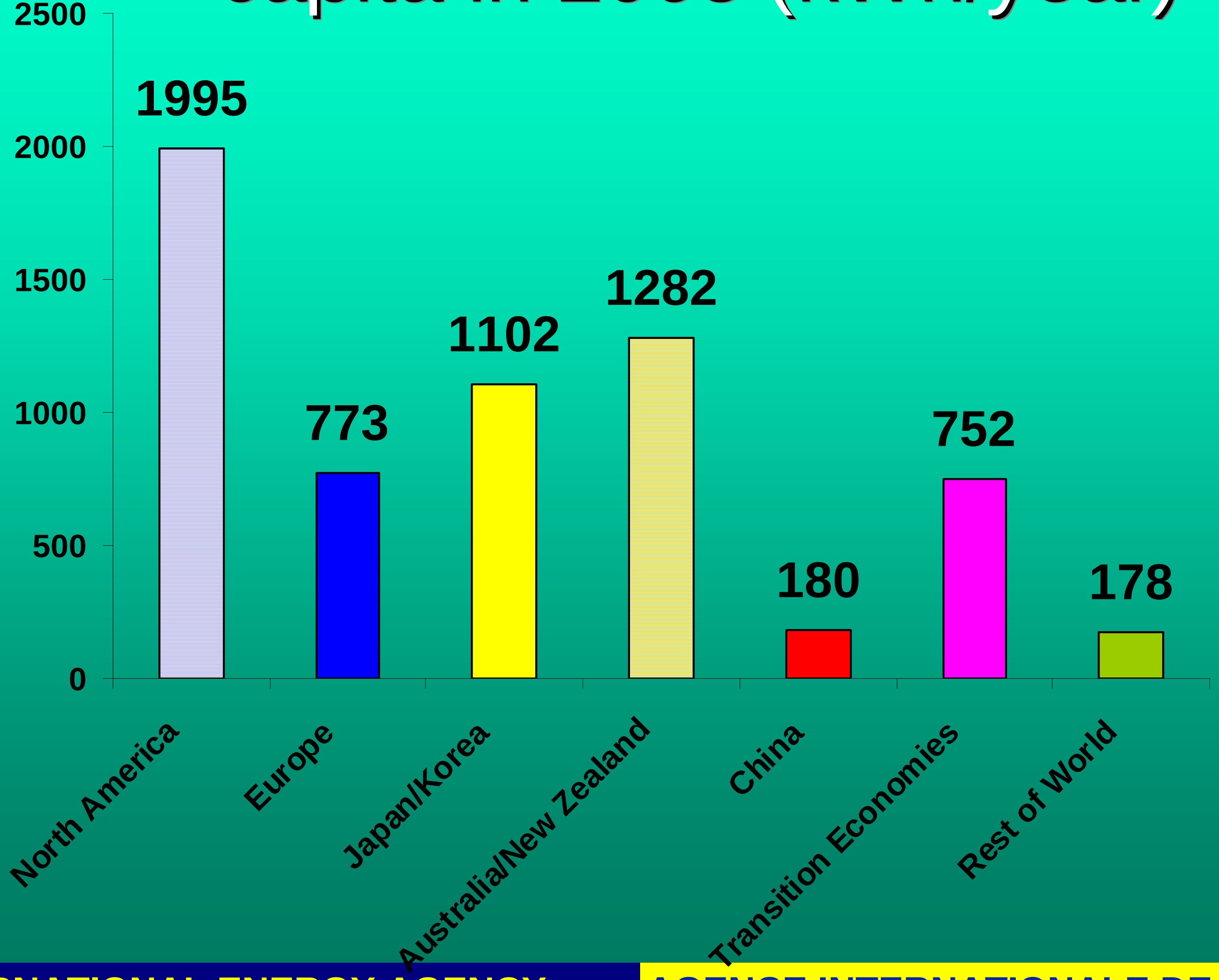
Figure 6-2 – Efficacy Comparison of Light Sources for General Lighting
Ballast watts included for discharge lamps systems. Sunlight and daylight ranges calculated inside of single pane clear glass and high performance glass.

Large differences in efficacy by region

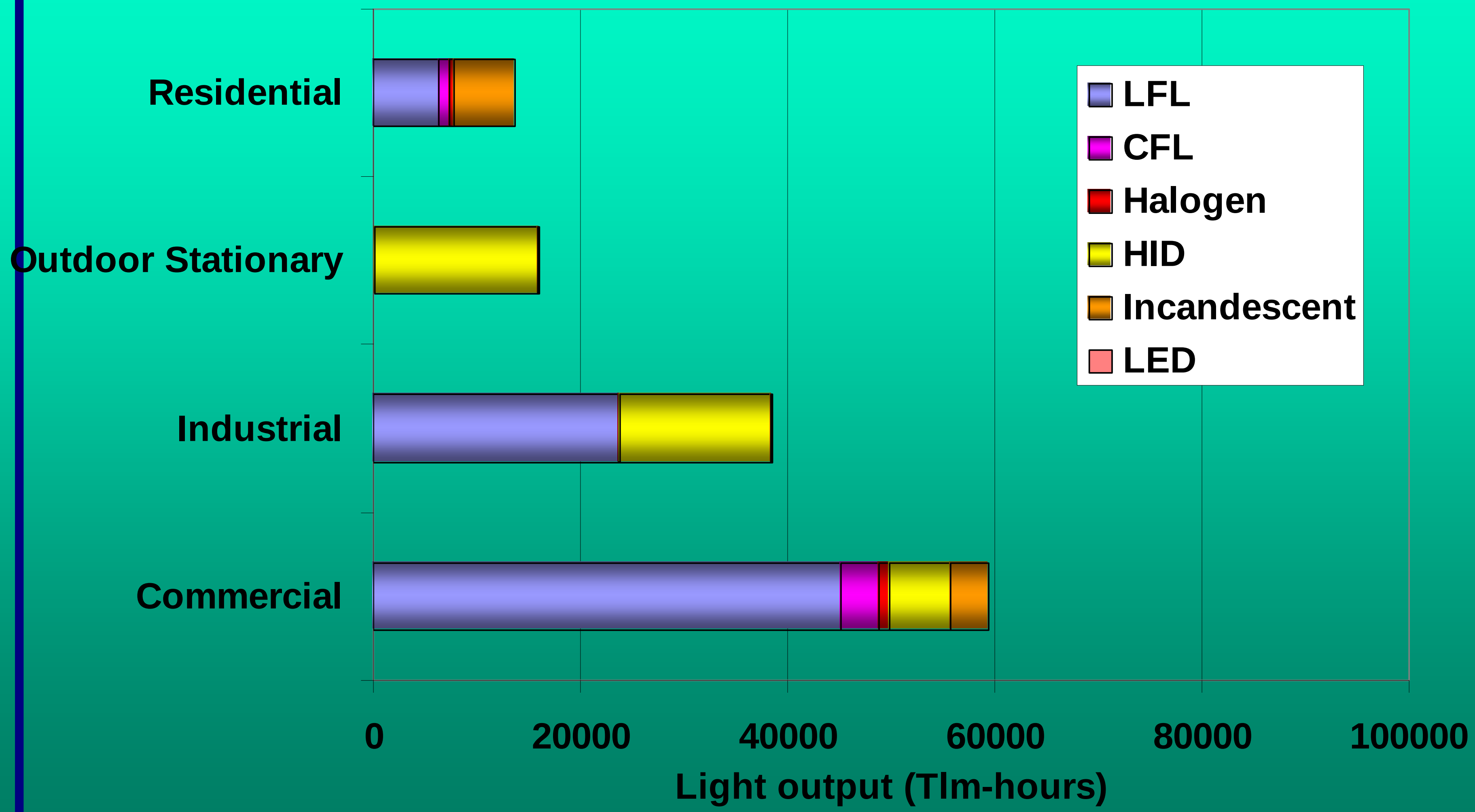
Global average electric lighting system efficacy was:

- 18 lm/W in 1965
- 48 lm/W in 2005
- Almost a factor of two variation between regions

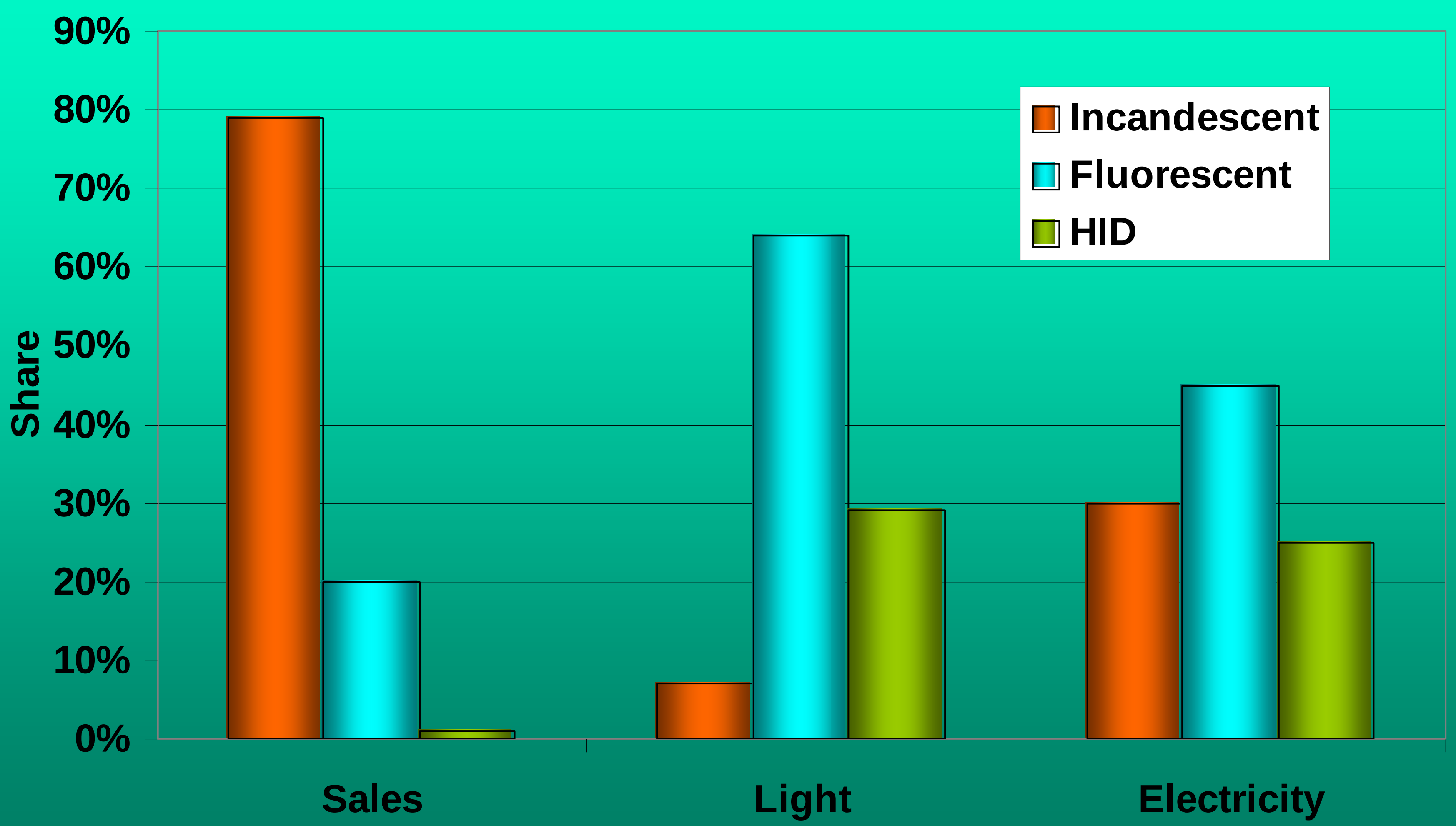
Lighting electricity consumption per capita in 2005 (kWh/year)



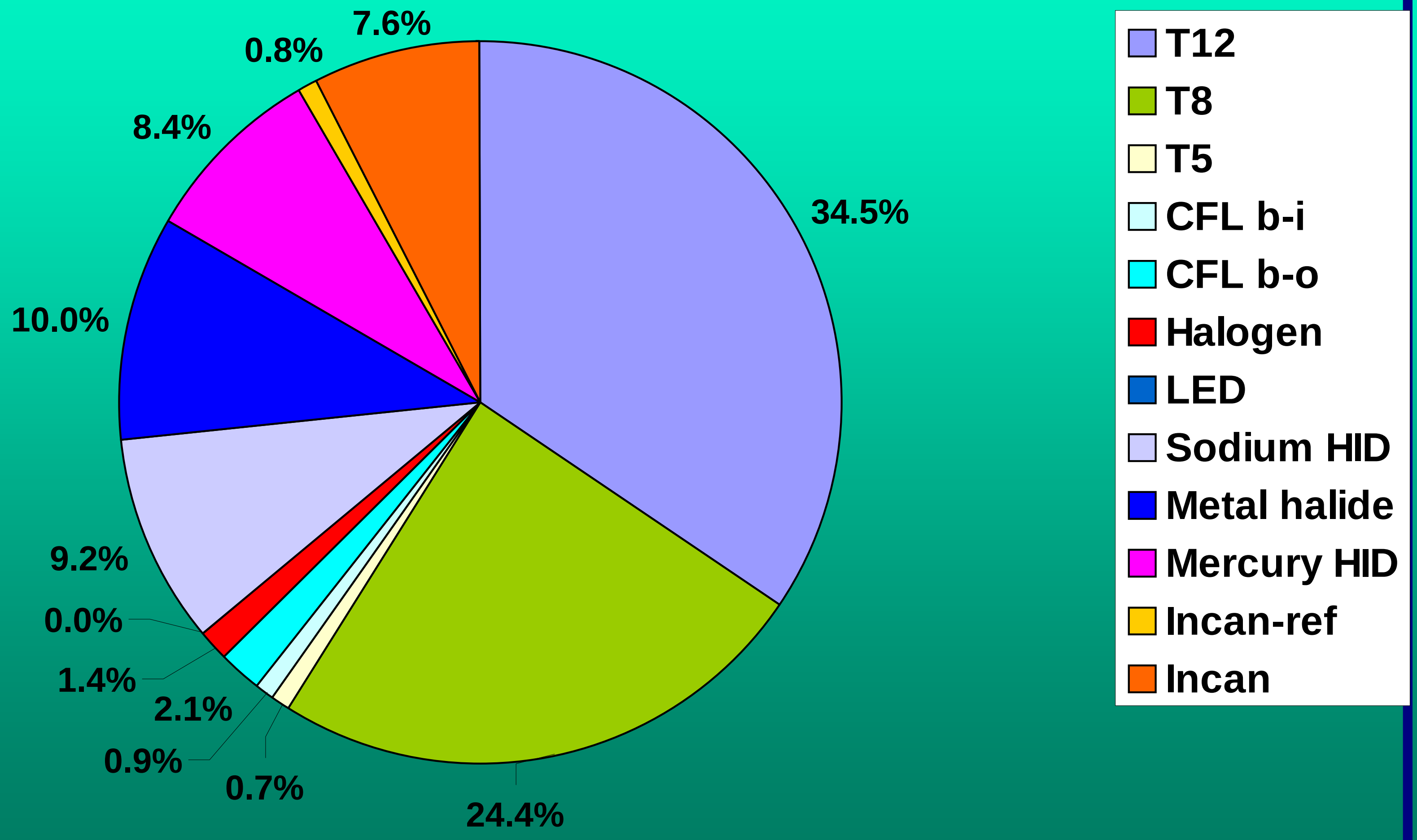
Total delivered light in 2005 (Teralumen hours)



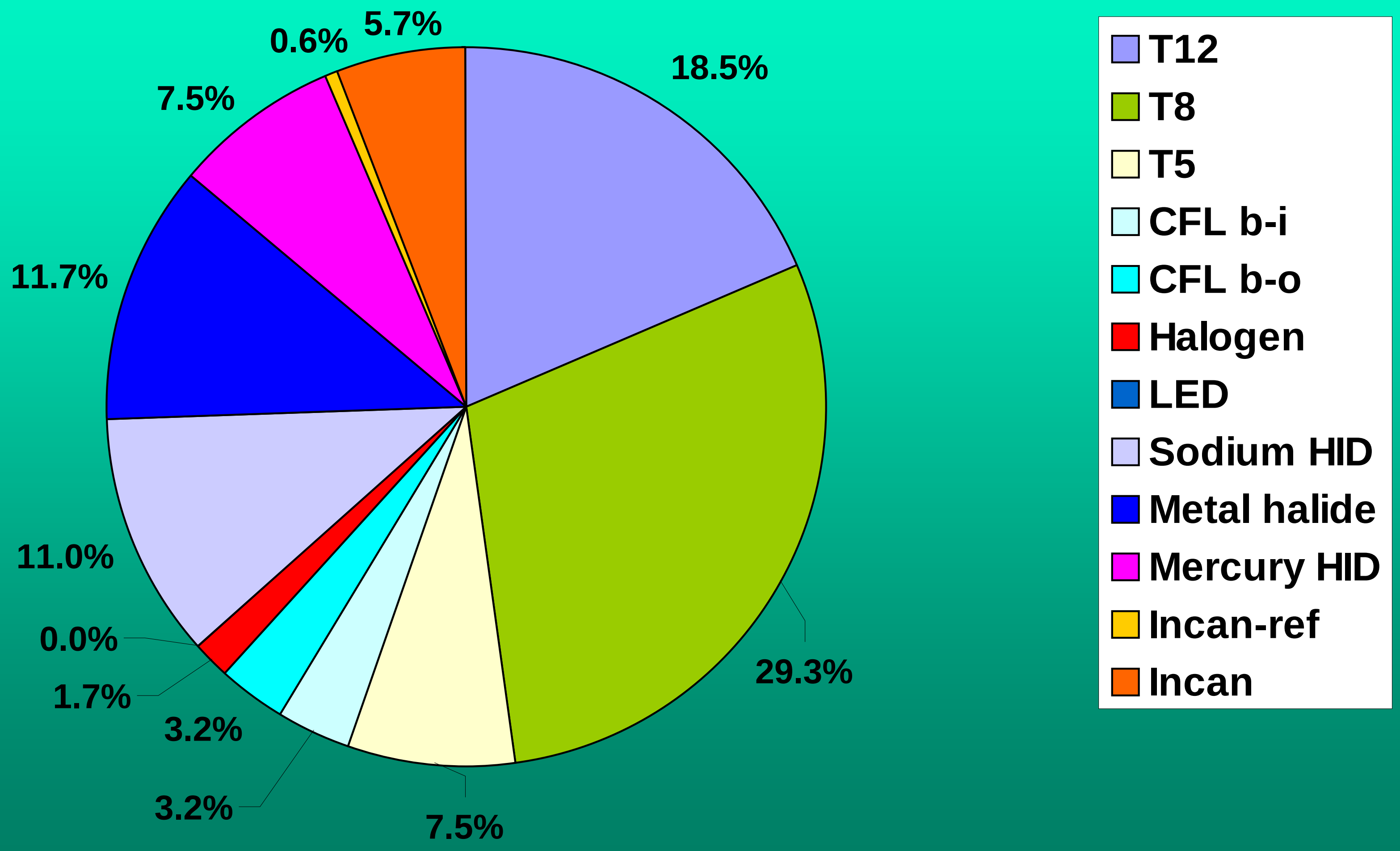
Global shares by main technology



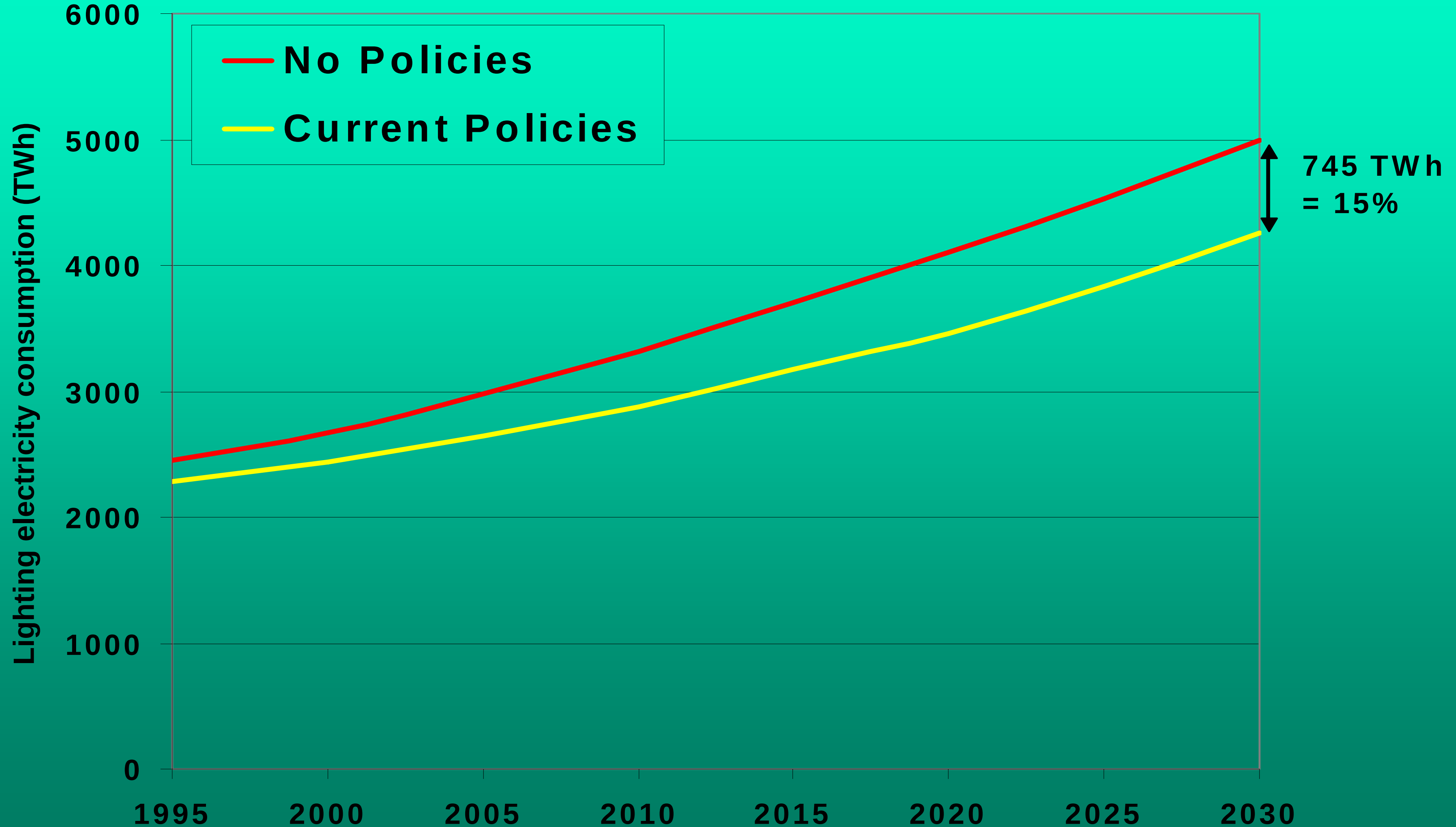
Light output by lamp type in 2000 (global total 113 Peta-lumen hrs)



Light output by lamp type in 2030 (global total 217 Peta-lumen hrs)



Energy consumption scenarios: “no-policies” and “current-policies”



Benefits from *Current Policies* compared to *No Policies*

Current policies are on course to provide global CO2 savings of:

- US$66 billion and 449 Mt CO_2 in 2030
- Cumulative savings of US$1529 billion and 13.8 Gt CO_2 from 1990 to 2030
- Cost of avoided CO_2 is negative (-US$151/tonne)

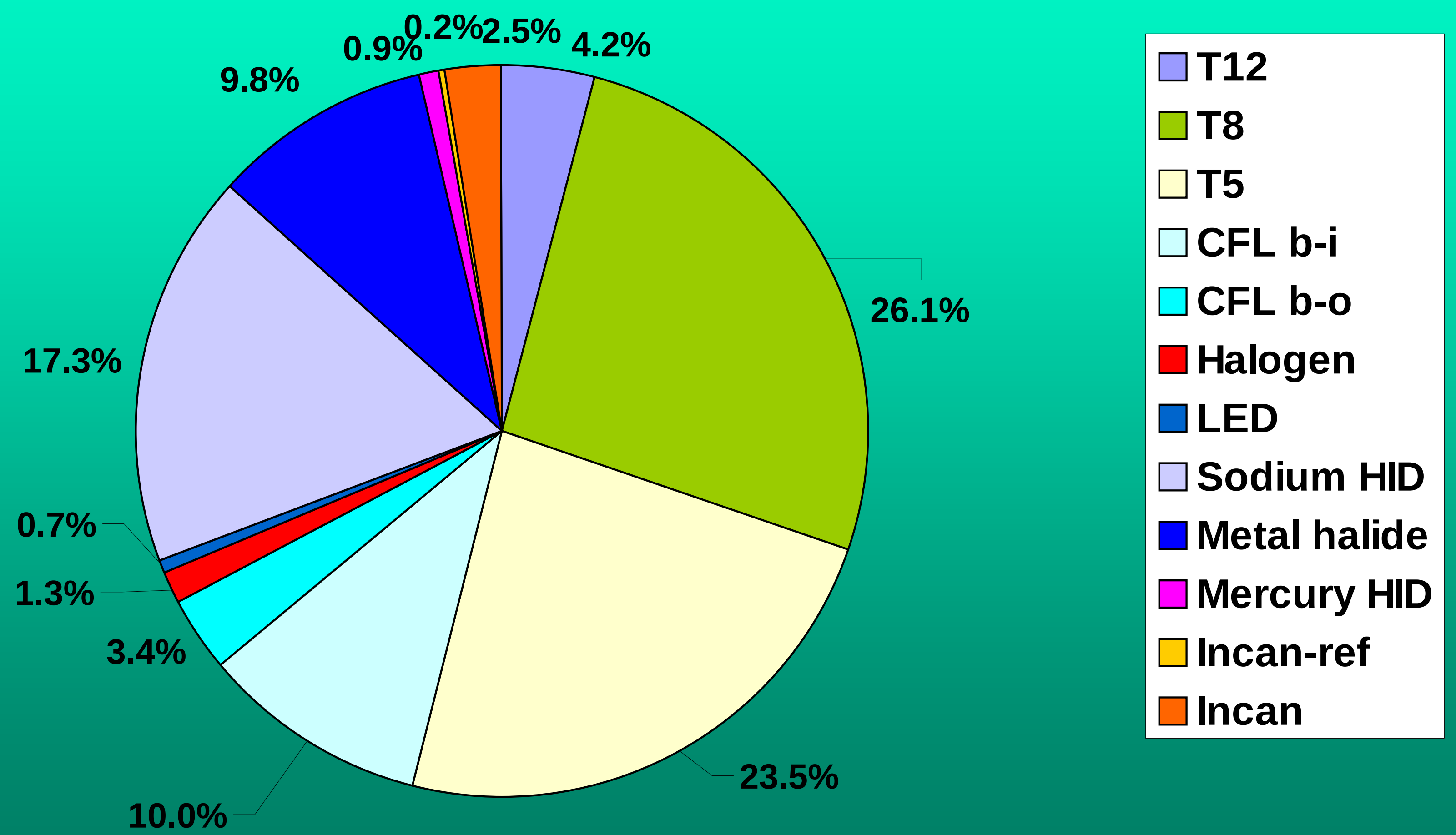
Assumptions under least-life cycle cost from 2008 scenario

In majority of cases when the operating hours exceed an economic threshold assume:

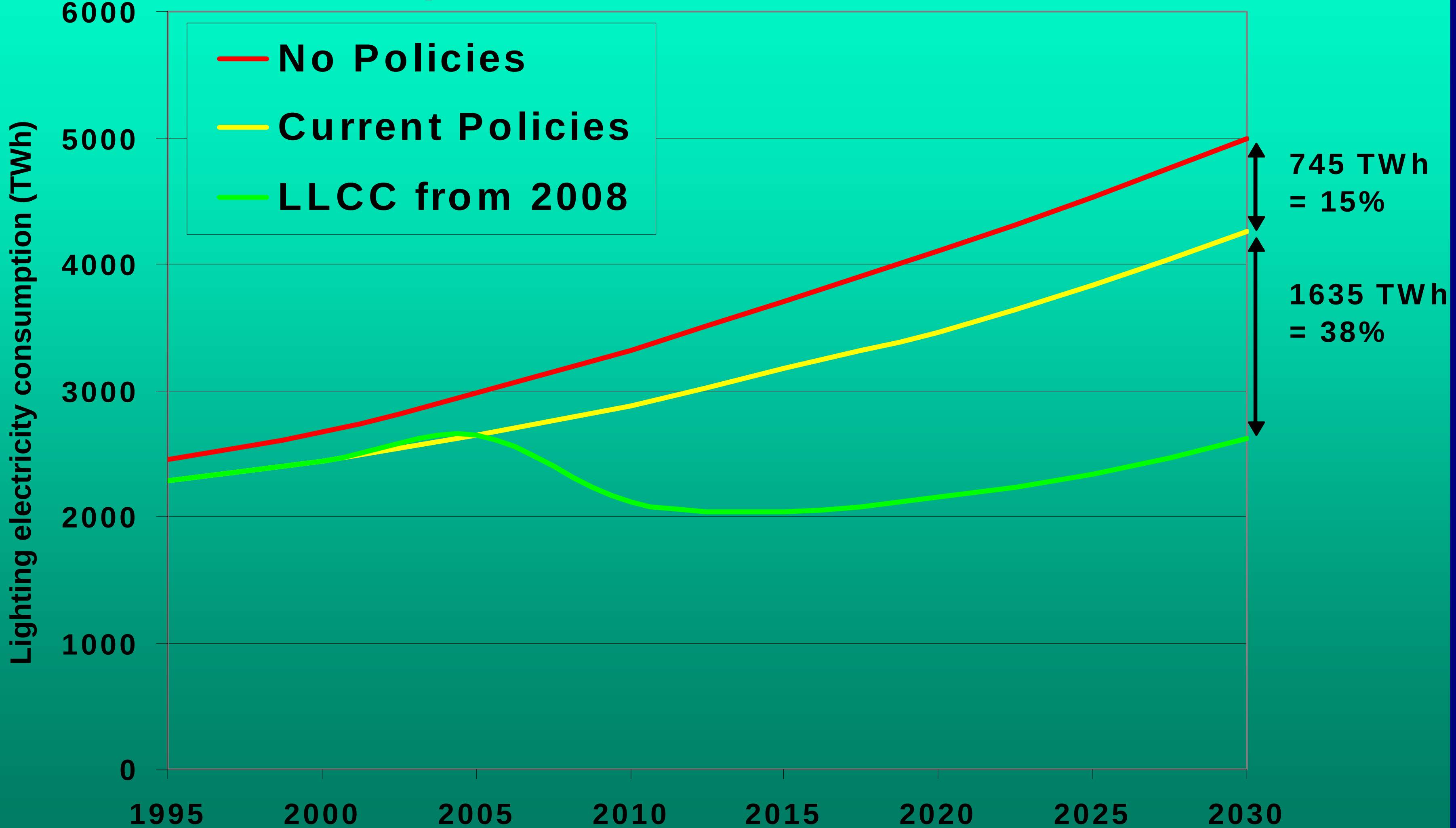
- CFLs replace incandescent lamps
- HPS and/or MH replace Mercury Vapour
- T12s and halo-phosphor T8s are replaced by tri-phosphor T8s and T5s
- Proportion of halogens replaced by LEDs (from medium term onwards). (Halogen torchieres phased out)
- Electronic ballasts
- Lighting controls (presence sensors, daylight dimming, etc.) only when energy cost > US$2.5/m2

In line with natural replacement cycles for lamps, ballasts and fixtures

LLCC Light output by lamp type in 2030 (global total 191 Peta-lumen hrs)



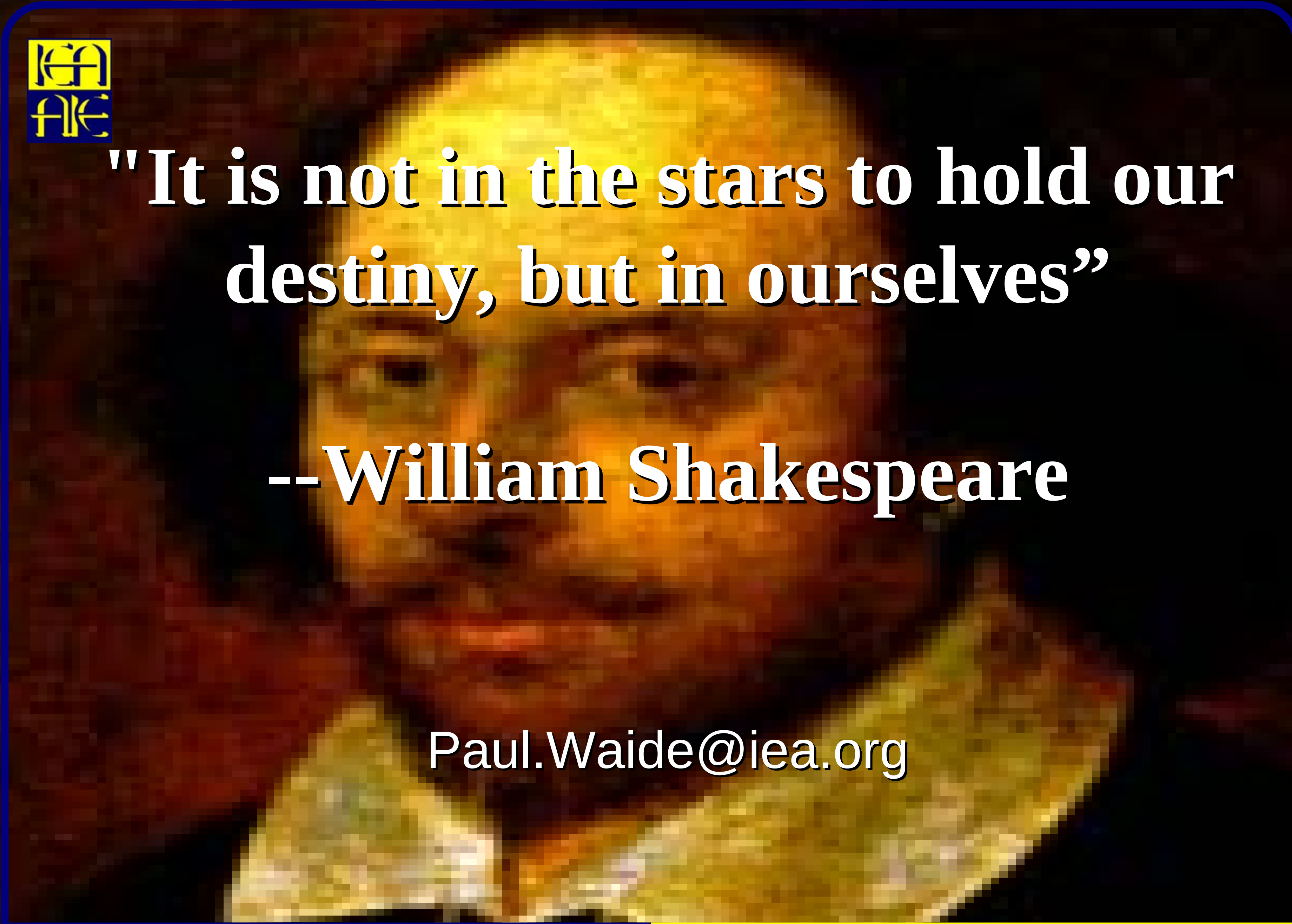
Energy consumption: no-policies, current-policies and LLCC-scenarios



Benefits from *LLCC* scenario compared to *Current Policies* scenario

The least life cycle cost from 2008 results in global savings of:

- US$156 billion and 971 Mt CO_2 in 2030
- US$2361 billion and 7.2 Gt CO_2 of cumulative savings to 2030
- Net cost of avoided CO_2 is negative (-US$158/tonne)



"It is not in the stars to hold our destiny, but in ourselves"

--William Shakespeare

Paul.Waide@iea.org