Energy efficiency improvements in vehicle lighting

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Outline

- Daytime use of headlamps and DRLs
- Other lighting applications
- Today's lighting fuel use
- Technology overview
- 4 scenarios for modelling the future
- Results of the worldwide modelling

Headlamps use during daytime for safety reasons

- **Impact on fatalities, injured and crashes**
  - A growing number of studies conclude on a sound safety effect of switching on headlamps during daytime
  - Crashes science highlight particular cases where the drivers do not notice up-coming vehicles even in very good weather conditions (because their attention may be lower, or caught by another event or vehicle)
  - Daytime use of headlamps address these cases and lead to an overall estimated decrease of 5% or more in number of crashes, injuries and fatalities
- **Additional fuel use**
  - Different studies range additional fuel use 1-3%
  - Our own calculation: 2% in the U.S., 3% in the E.U.
  - A major political barrier (Germany, NL, Austria)

Headlamp or Daytime Running Lights?

- **Headlamps are switched together with other devices**
  - (parking lamps, rear tail lamps, side markers, dashboard, etc.)
  - Power draw exceed 58W (low beams 110W)
- **DRL: lower power – switched alone**
  - Automatically switched on with the engine and overtaken by the regular headlamps
  - Only designed for the car to be seen (not to project light and enable night vision)
  - Lower operating power and front lighting alone
  - Consist either in low beam fixture switched at lower voltage, or specific projectors (typically 2x40W)
- **Energy impact for one car (-53%)**
  - 72 kWh/yr for headlamps vs 34 kWh/yr for DRLs

Regulations on daytime lighting

- **Countries with a regulation regarding daytime use of low beams**
  - **All the year: Canada, Ireland and all Scandinavian countries on all roads; Hungary and Italy on rural roads only**
  - **During the winter season only: Poland, Lithuania, Czech republic on all roads and Israel on rural roads only**
- **Canada has introduced the same year (1989!) the mandatory use of front lighting during daytime AND the mandatory equipment of new cars with DRL**
- **E.U. is considering taking action**

Other lighting applications

LAMP APPLICATION	Operating time*	WATTAGE		
	Hours/year	incadesc.	HID – Xenon	LED**
Headlamps - High Beam	24	65	35	50
Headlamps - Low Beam	115	55		40
Front Turn Signals	30	25		8
Front Parking Lamps	115	8		1.5
Rear Stop Lamps and Turn Signals	61	26		8
Rear Tail Lamps	115	7		2
CHMSL, Exterior Mount	61	18		2
CHMSL, Interior Mount	61	36		5
License Plate	115	4		1
Reverse Indicator	12	25		2.5
Side Marker	115	3		1
Fog Lamps	120	40		not available
Daytime Running Lamps	341	40		31

* Time of operation for a typical US use – varies from one country to the other
** As reported by Navigant for DOE, 2003 – technologies have evolved since then

Today's lighting fuel use

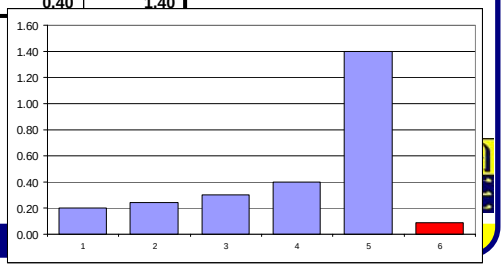
- External lighting of road vehicles in 2002:
  - about 1,300 Tlm.h
  - 55 billions litres of gasoline (which is about 3.2% of the total energy use of those vehicles)
  - 1.1 million barrels of crude oil per day (with inclusion of the upstream needs)
  - Reminder: IEA emergency stock release during Katrina-Rita crisis 2mb/d over 30 days

Cost of delivered electricity

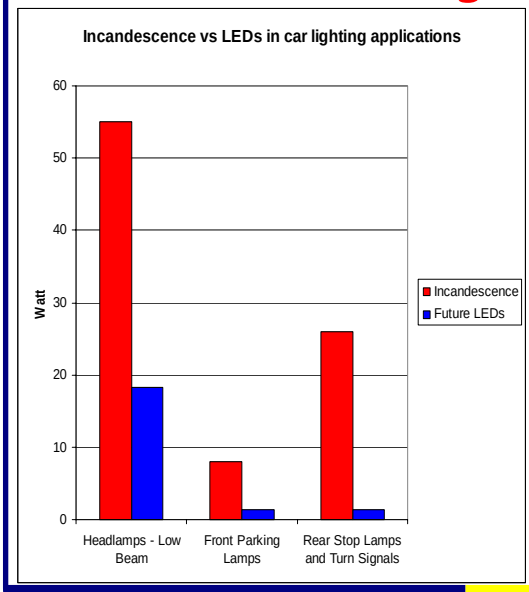
Assumptions used

- Motor Yield 25% for LDVs (35% for trucks)
- Alternator Yield 50%
- No battery charge/discharge loss accounted

	Assumptions of gasoline cost / result kWh cost				
US$/gallon	1.0	1.2	1.5	2.0	7.0
Euro/liter	0.22	0.26	0.33	0.44	1.54
US$/kWh	0.24	0.29	0.36	0.48	1.68
Euro/kWh	0.20	0.24	0.30	0.40	1.40



Vehicle Lighting (1)



Color LEDs are more efficient because they emit directly in the good wavelength

White LEDs:

- **20 lm/W in 2002**
- **30 lm/W in 2004**
- **40 lm/W in 2005**
- **60 lm/W announced for 2006**

Assumption:

LED efficiency continue rising up to 100 lm/W

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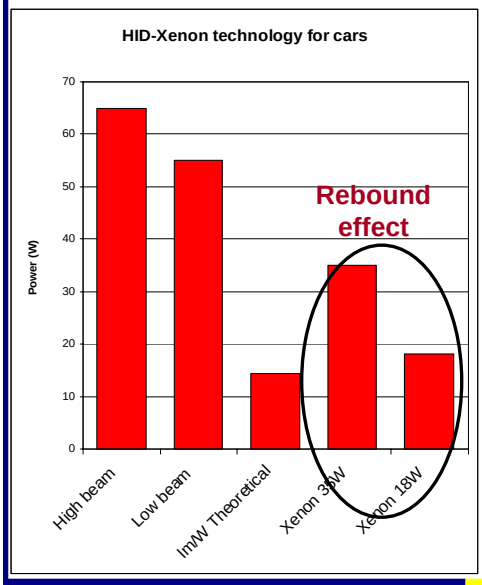
Vehicle Lighting (2)



HID-Xenon is a mature technology that reaches 100 lm/W

The existing product:

- **35W, over 3000 lm**
- **Needs self-leveling device**
- **Colour rendering index**
- **Rebound effect**

Assumption:

Development of another product with lower power

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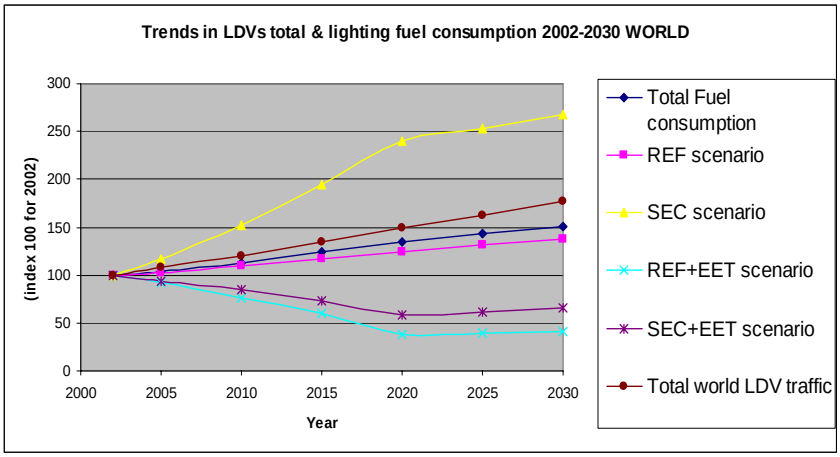
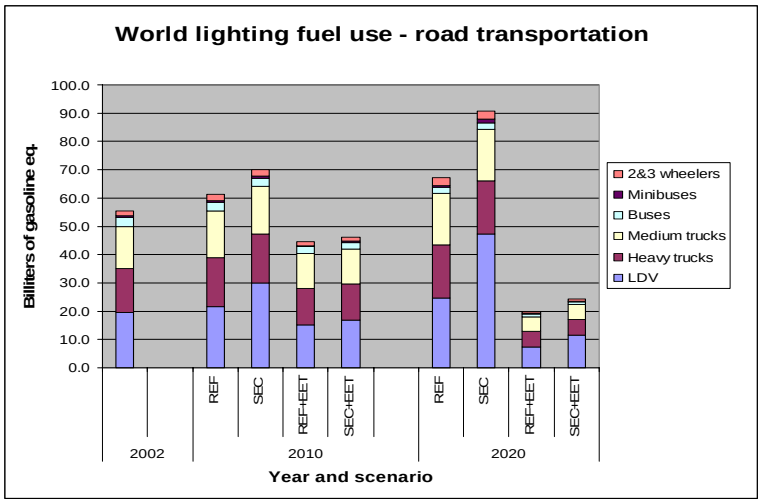
Four scenarios for road vehicle lighting energy use

- The reference (REF) scenario has low technology profile (poor HID-Xenon and LED development and use)
- The security (SEC) scenario introduces mandatory use of either low beams or DRLs during daytime (progressively spreading until 2020). DRLs are not compulsory for new cars – DRL equipment rate unchanged.
- First energy efficiency technologies scenario (REF+EET): same as REF but all the market shifts to "18W" HID-Xenon and/or very efficient (future) LEDs for all applications.
- SEC+EET scenario applies the same technology assumptions to the SEC scenario. Plus DRLs equipment is mandatory for new cars.

The case for LDV



Results for all road vehicles



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