



Feasibility of LED as interior train lighting

Presentation at Railways Interior Expo
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28th November, Koeln

HYA03-291144

LED FOR INTERIOR LIGHTING
LLOYD'S REGISTER RAIL EUROPE

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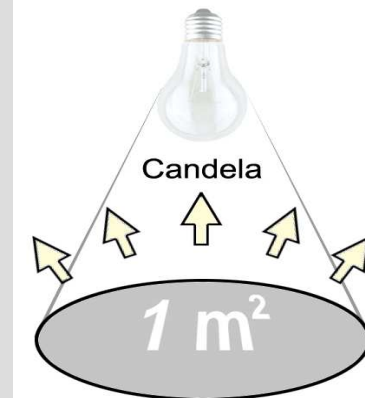
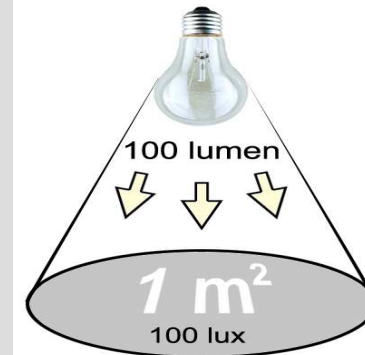
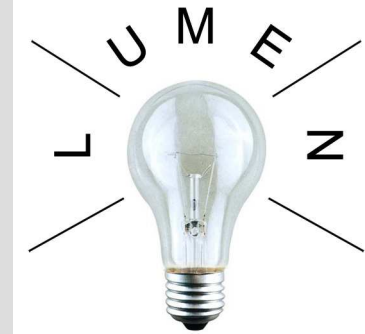
Contents of presentation

- Lighting basics; explanation of key parameters in lighting.
- Comparison between LED and fluorescent tubes
- Life cycle costs calculation
- Case study DDM



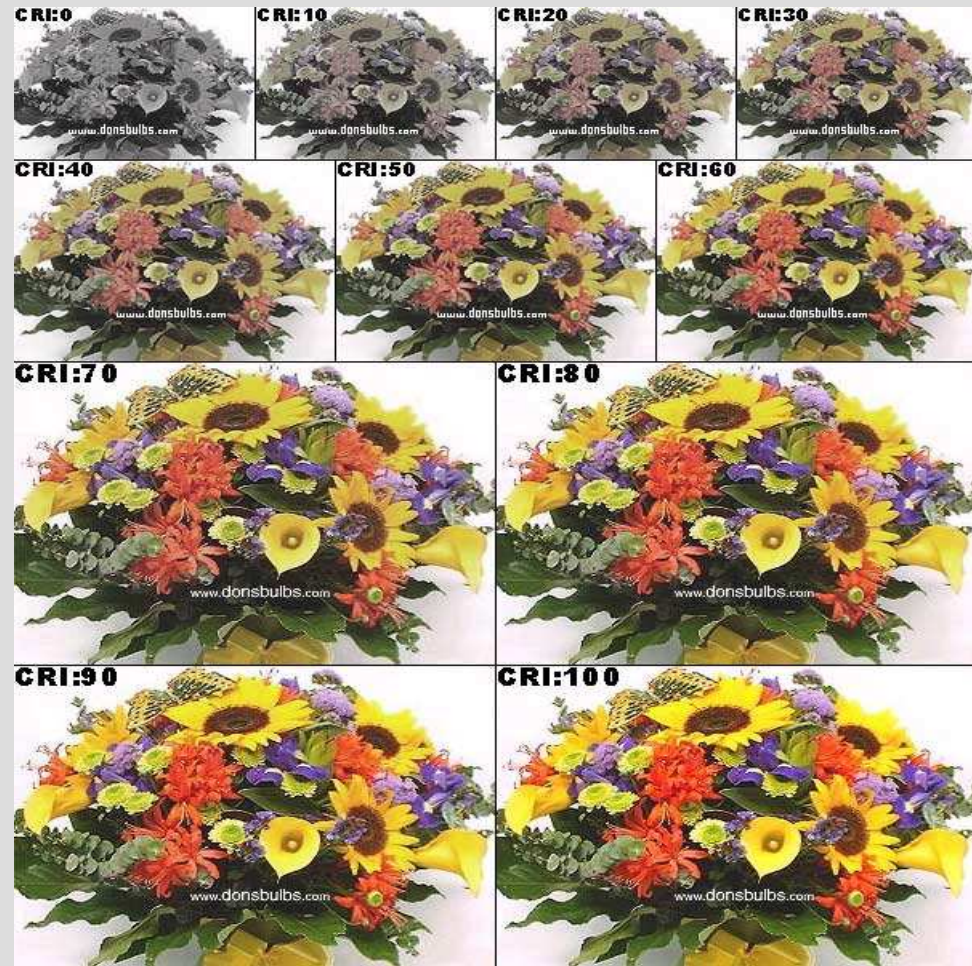
Light definitions

- Light current is defined in Lumen.
 - Efficiency is defined by Lumen/Watt
 - Fluorescent tubes generate about 80 L/W
 - One fluorescent tube generates about 2500 Lumen
- The amount of light at a certain area is defined in Lux
 - For reading a newspaper about 150 Lux is comfortable



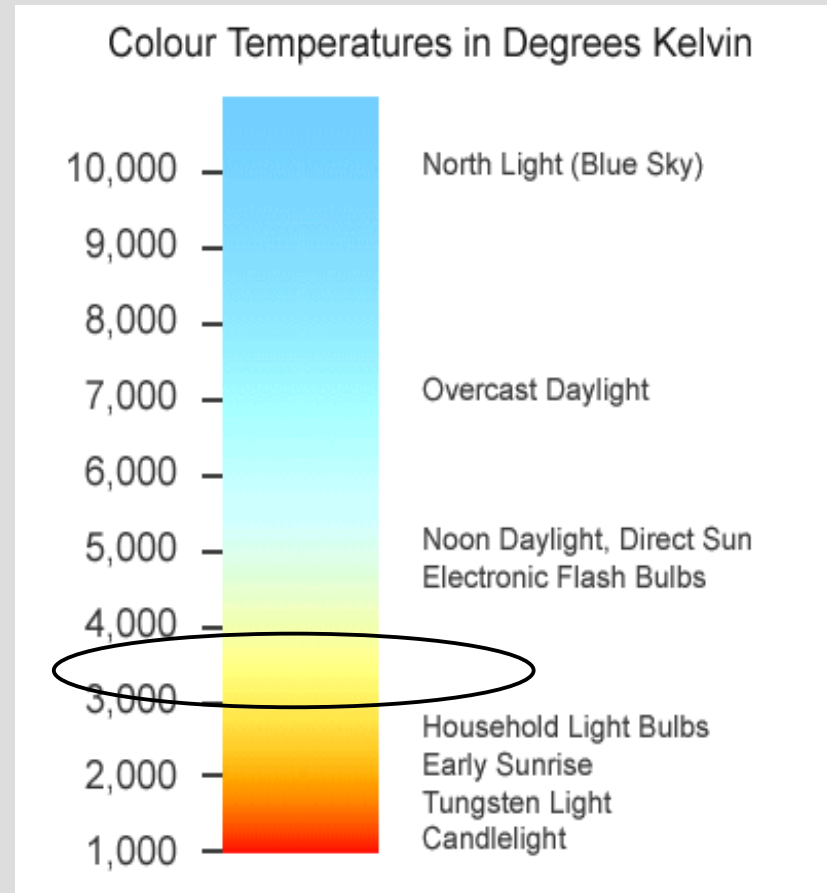
Colour rendering index

- Describes colour perception caused by the availability of spectral power distribution.
- A higher value causes colours to be perceived more brilliant.
- A general available fluorescent tube has a CRI of 80
- Sunlight has a CRI of 100
- A CRI of 80 is the minimum desired value for train lighting.

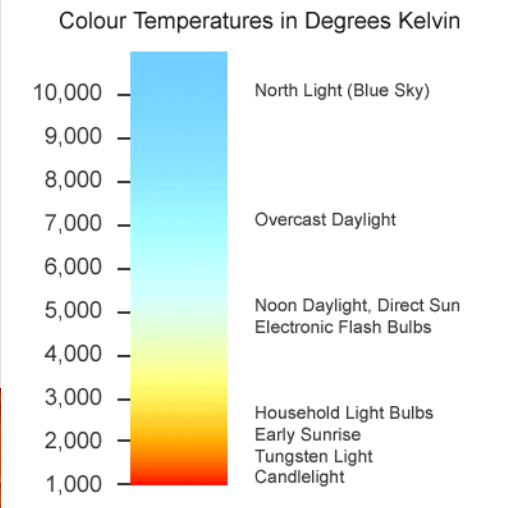


Colour temperature

- The colour temperature describes the light's colour.
- The desired colour temperature can differ per culture
 - Southern cultures tend to like higher colour temperatures, generating “cold” light.
 - Northern European's tend to like “warmer” light, in the range of 3300K.
- Fluorescents have a set colour temperature, depending on the type.
- RGB-LED's can generate every desired colour temperature.



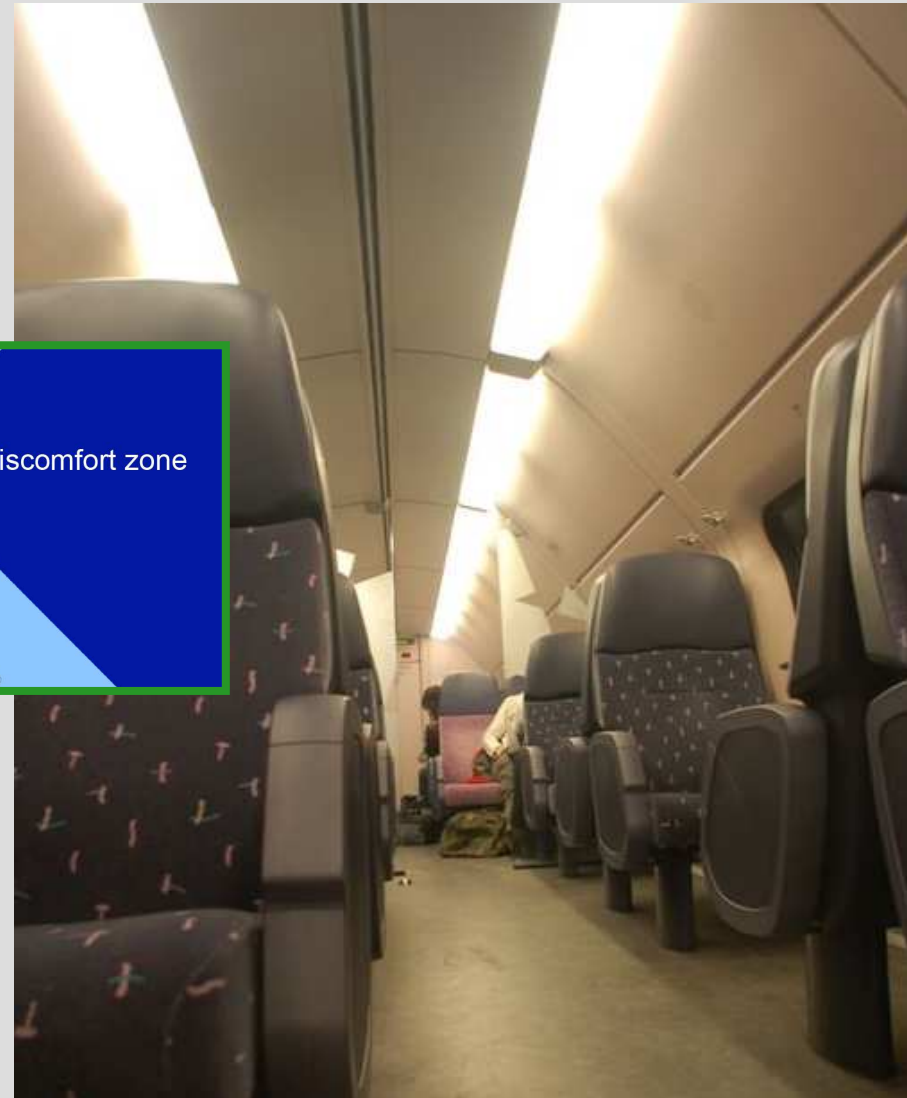
Colour temperature influences the atmosphere in a room



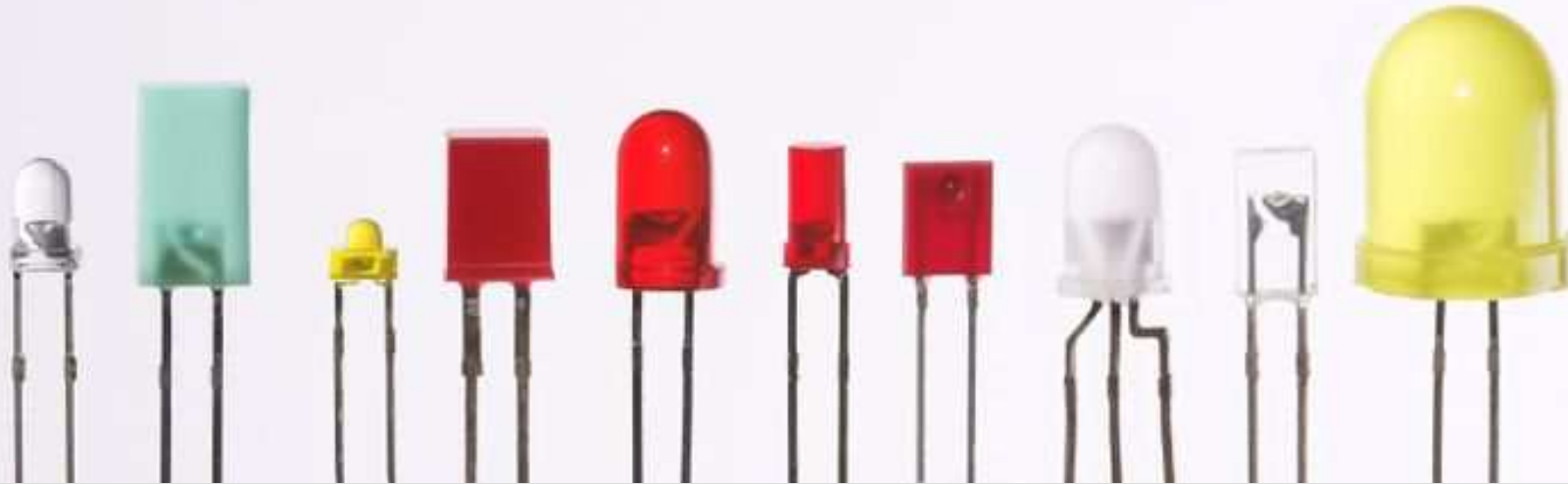
Supperclub San Francisco

Contrast

- Contrast is the ratio between maximum and average light intensity levels.
- Contrast should be max. 1:10
- The placement and configuration of the lighting source require special attention to obtain the desired contrast.



LED: history



Red LED since 1962

Green LED developed in 1970's

Blue LED discovered in 1993

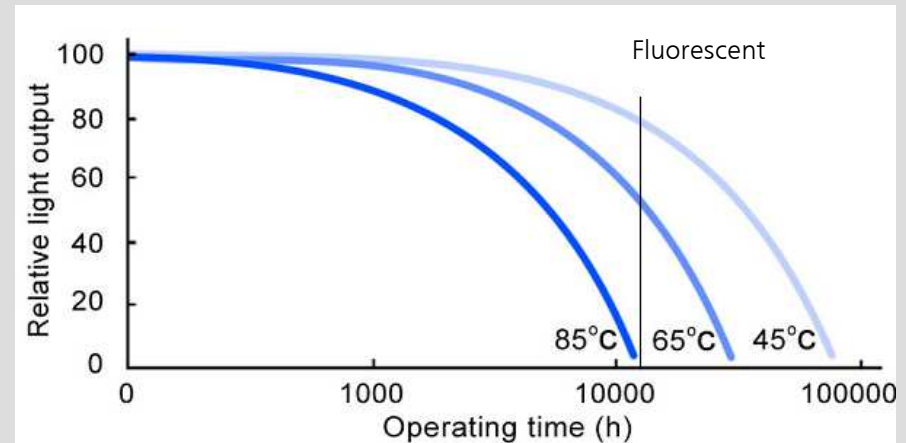
Since 2000: high intensity white LED

- *from blue LED with fosfor*
- *RGB*



LED life span

- Life span is one of main benefits of LED
- Strongly dependant on operating temperature
- LED slowly fades out in stead of failing
- No standard definition on “life span”
- 70% remaining intensity is often used for defining life span



LED compared to fluorescent tubes



2006 data:

- efficiency up to 80 lm/W
- price > 100 Euro per 2500 lm
- life span 50.000 hours



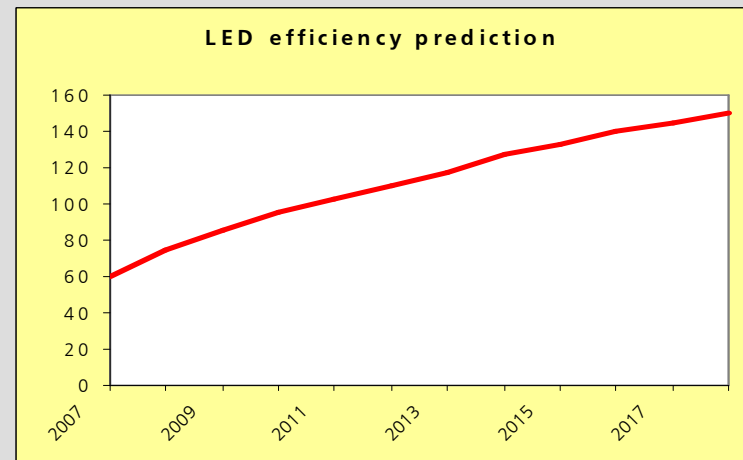
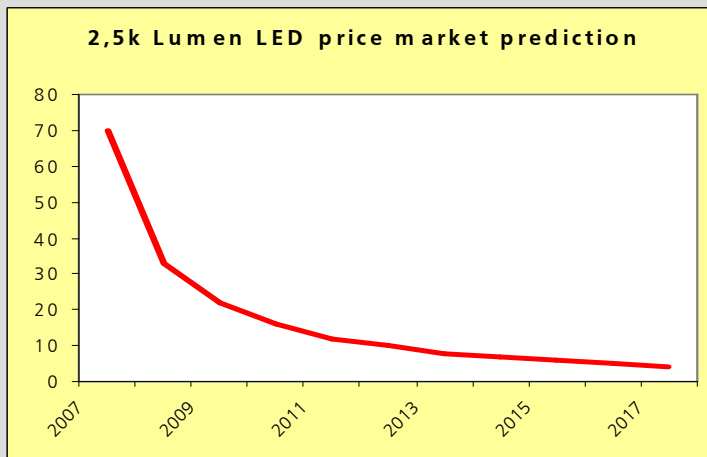
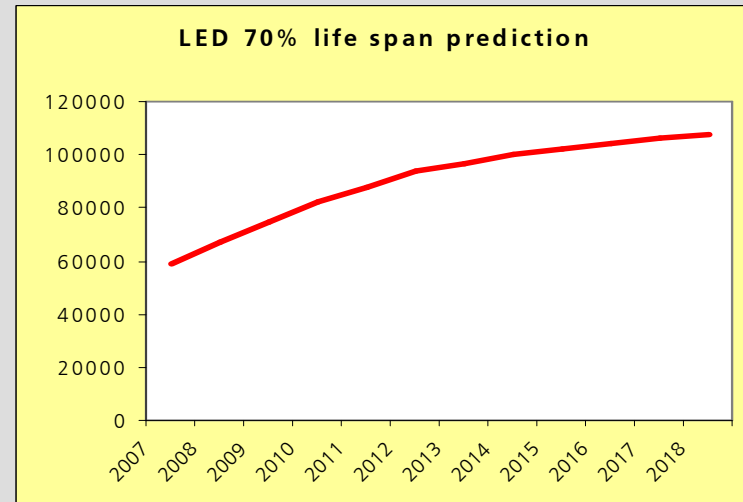
general:

- efficiency 80 lm/W
- price 2 Euro per 2500 lm
- life span 12.000 hours

Future of LED

Promising evolution in field of:

- Efficiency [Lumen/Watt]
- Price [Euro/2500Lumen]
- Life span [hours]



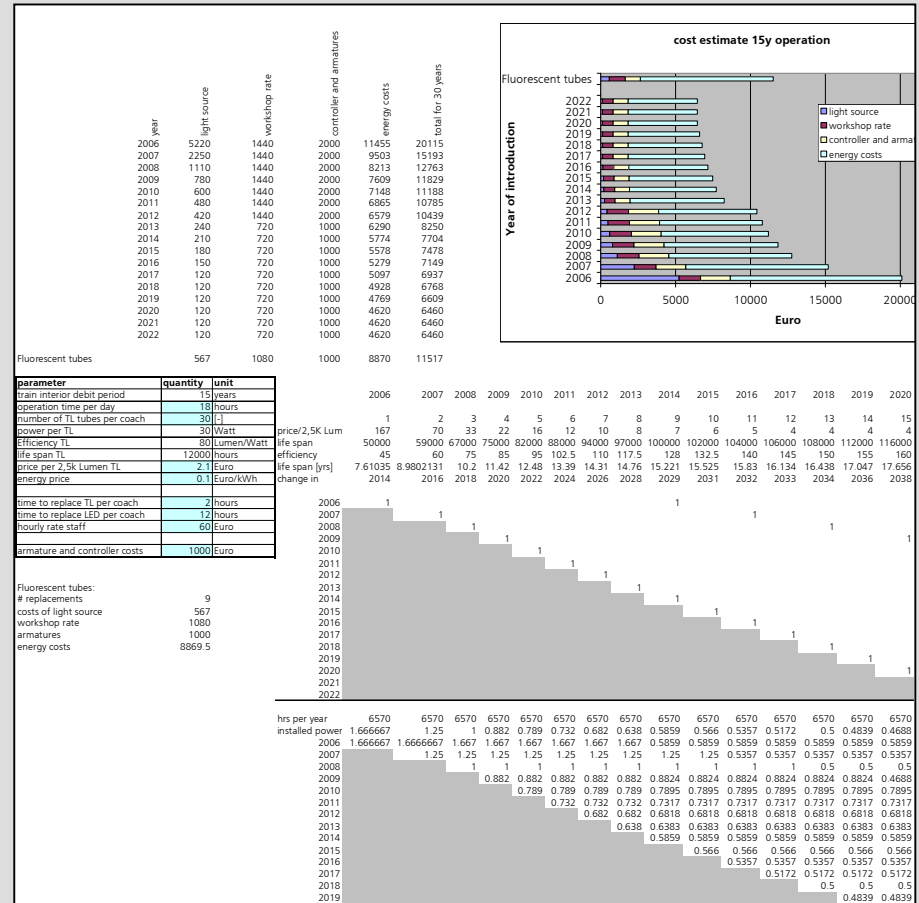
Life cycle cost calculation

Input:

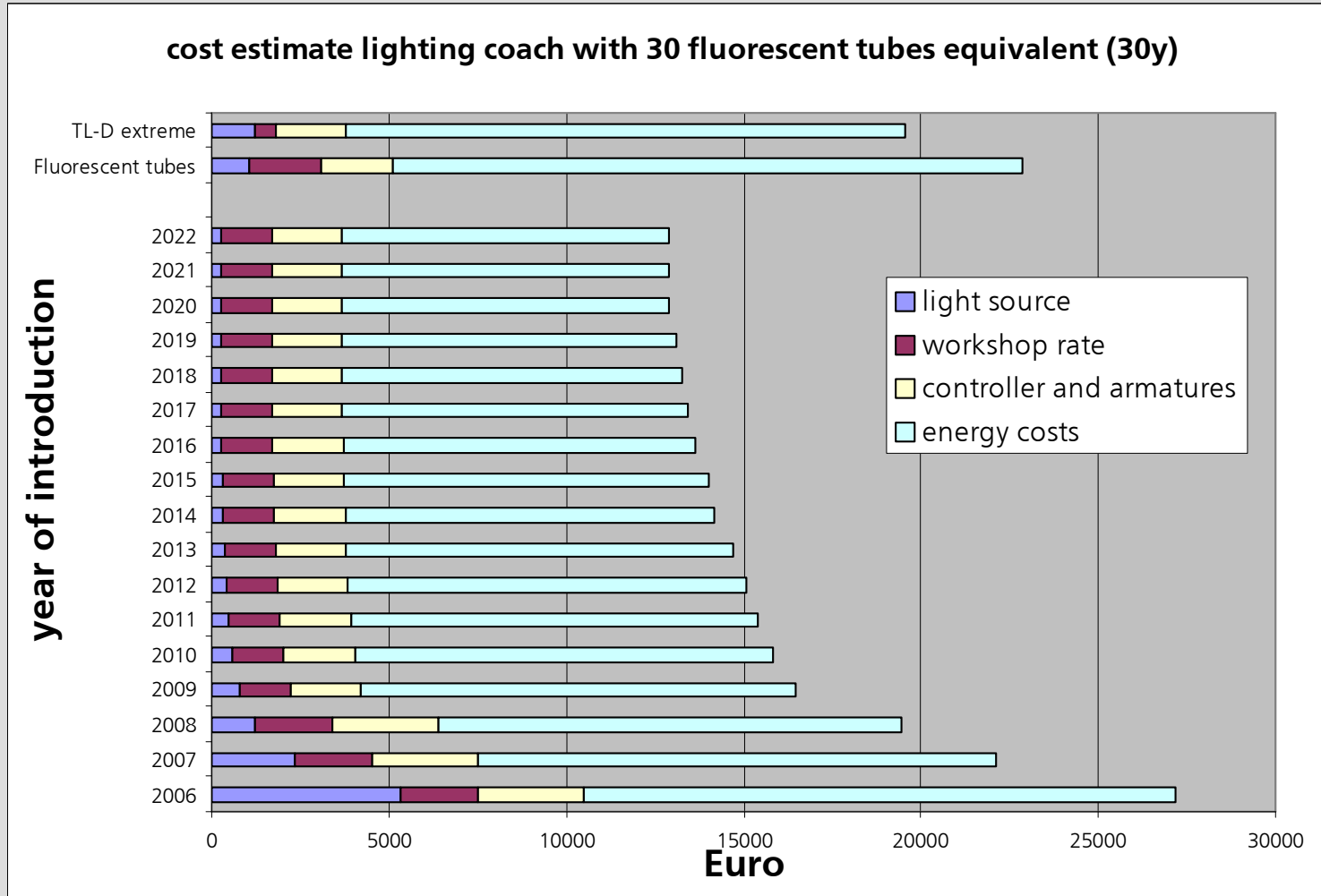
- Debit period 15 or 30 years
- Initial investment costs
- Maintenance costs
 - Replacement material costs
 - Time to replace: workshop rate
- Energy costs

Taking into account:

- Comparison between two types of fluorescents and LED
- LED evolutions in the field of efficiency, price and life span

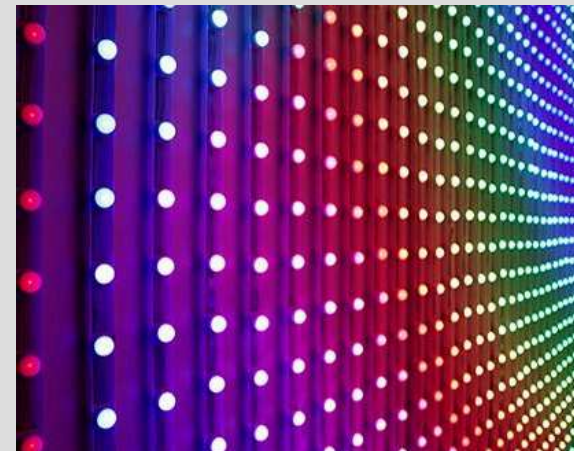
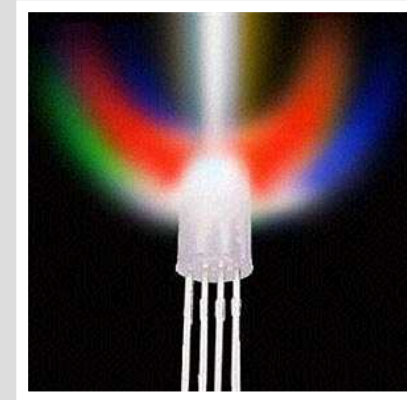


Life cycle costs in train interior implementation



Life cycle costs summary

- Purchase price per lumen of LED will remain higher than that of fluorescent tubes, also in the future.
- Energy efficiency of LED will be better than fluorescents in the near future.
- Trigger for introduction should come from the company that pays energy bills (e.g.TOC).
- Maintenance task is lower for LED, due to much higher life expectancy.
- The energy costs are the highest fraction of the life cycle costs. Once LED is more efficient than fluorescent tubes, introduction date is nearby.
- From 2009, LED will be preferable from a LCC point of view.



LED implemented in architectural lighting



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Aircraft LED lighting



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Train lighting (fluorescent)



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Case study: refurbishment of double deck coaches

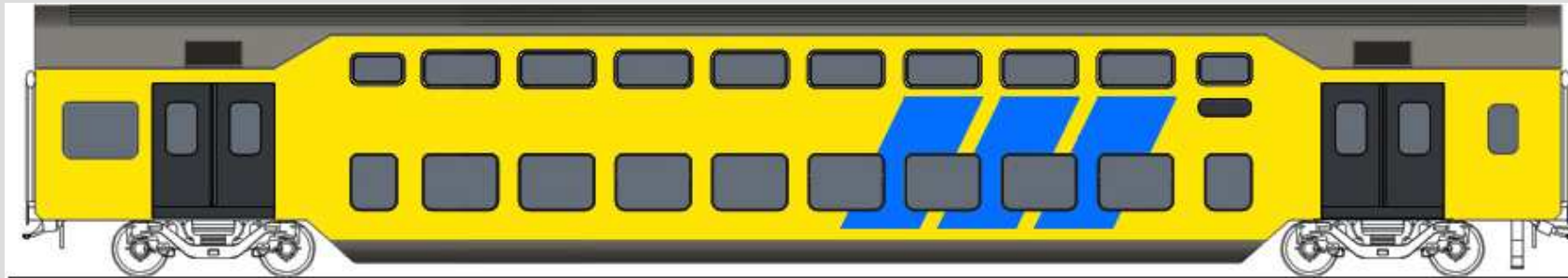


goals to achieve:

- atmosphere improvement
- lower contrast level
- good lighting levels

conditions:

- double deck: low ceiling, little space
- heat management for LED life span



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Case study: results

All design, light calculations and renderings performed in-house at Lloyd's Register Rail Europe.



Existing lighting situation

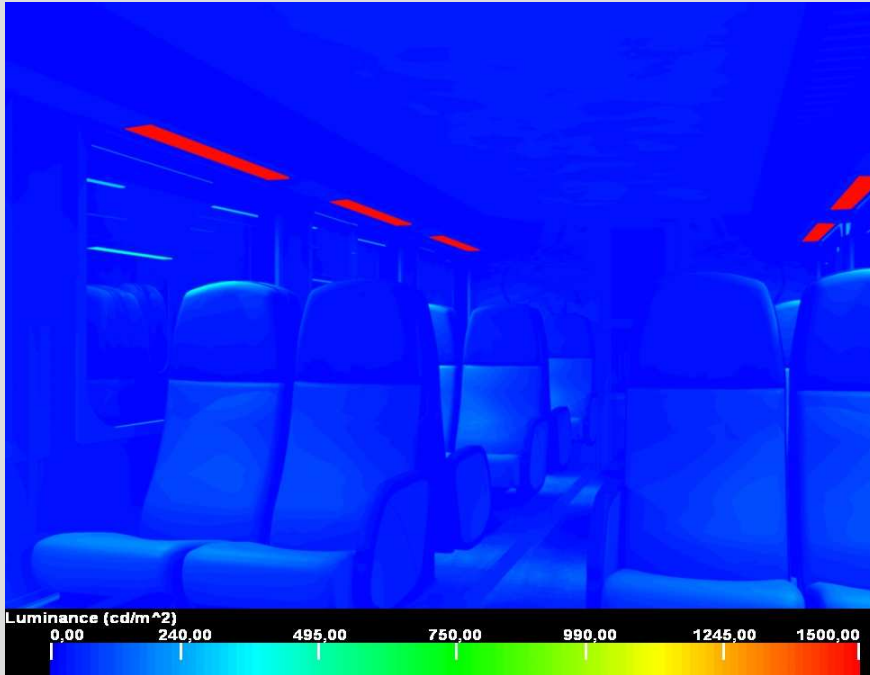


LED lighting situation

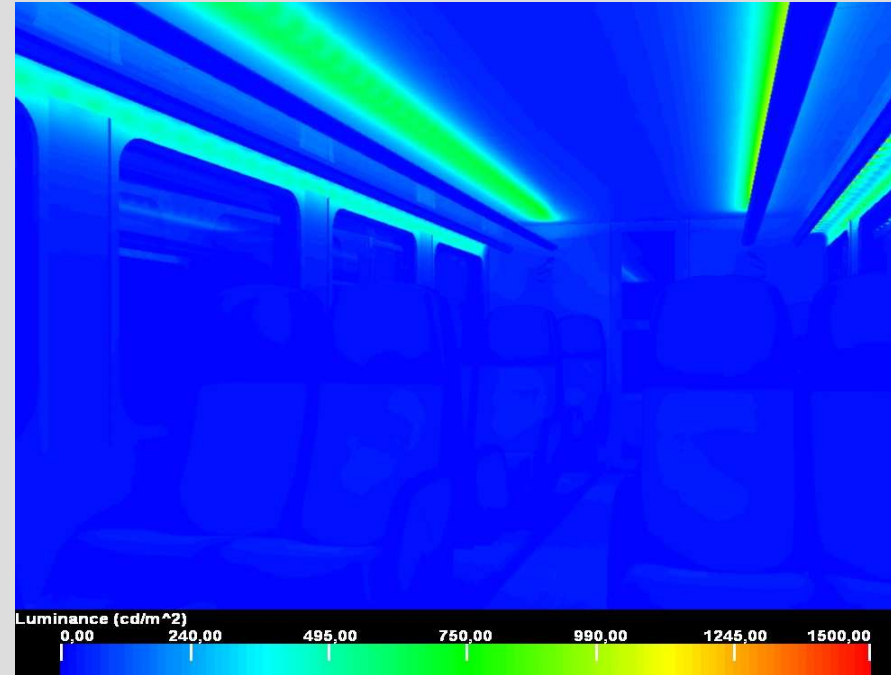
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Case study: contrast levels by light simulations

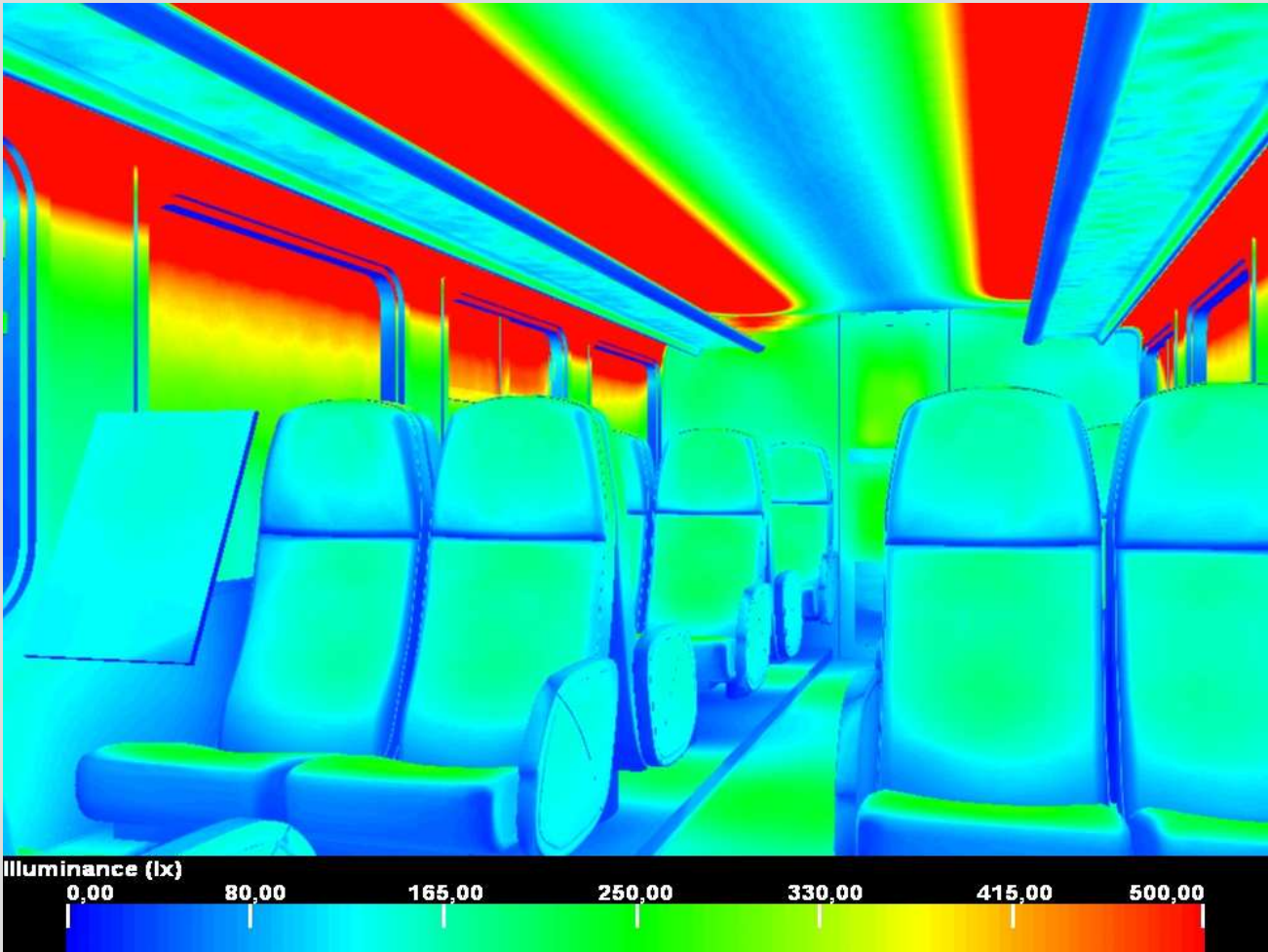


Old situation: contrast exceeds 1:10



LED: contrast about 1:6

Case study: lighting levels



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Case study: atmosphere by changing light colour temperature



Colour temperature about 4000K



Colour temperature about 3000K

Case study: atmosphere by changing the colour of ceiling and side walls (colour temperature is equal)



Colour temperature about 4000K



Colour temperature about 4000K.
Yellow ceiling and side walls.

Case study conclusions

- Indirect lighting provides lower contrast levels.
- Due to better light distribution, the installed light current remains equal.
- By lighting the ceiling, a spacious effect is created. This is specially interesting for double deck coaches.
- The light colour temperature should match the interior material's colour
- Heat dissipation of LED must be taken into account from the start of the design process.
- LED strips are compact and can therefore be fitted in very slim armatures.
- Light design simulations give good insight into the atmosphere in an early stage of the project.
- Lloyd's Register Rail Europe can perform independent light design, calculations and simulations.



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Closing page

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