



# Grid control with LED lamps

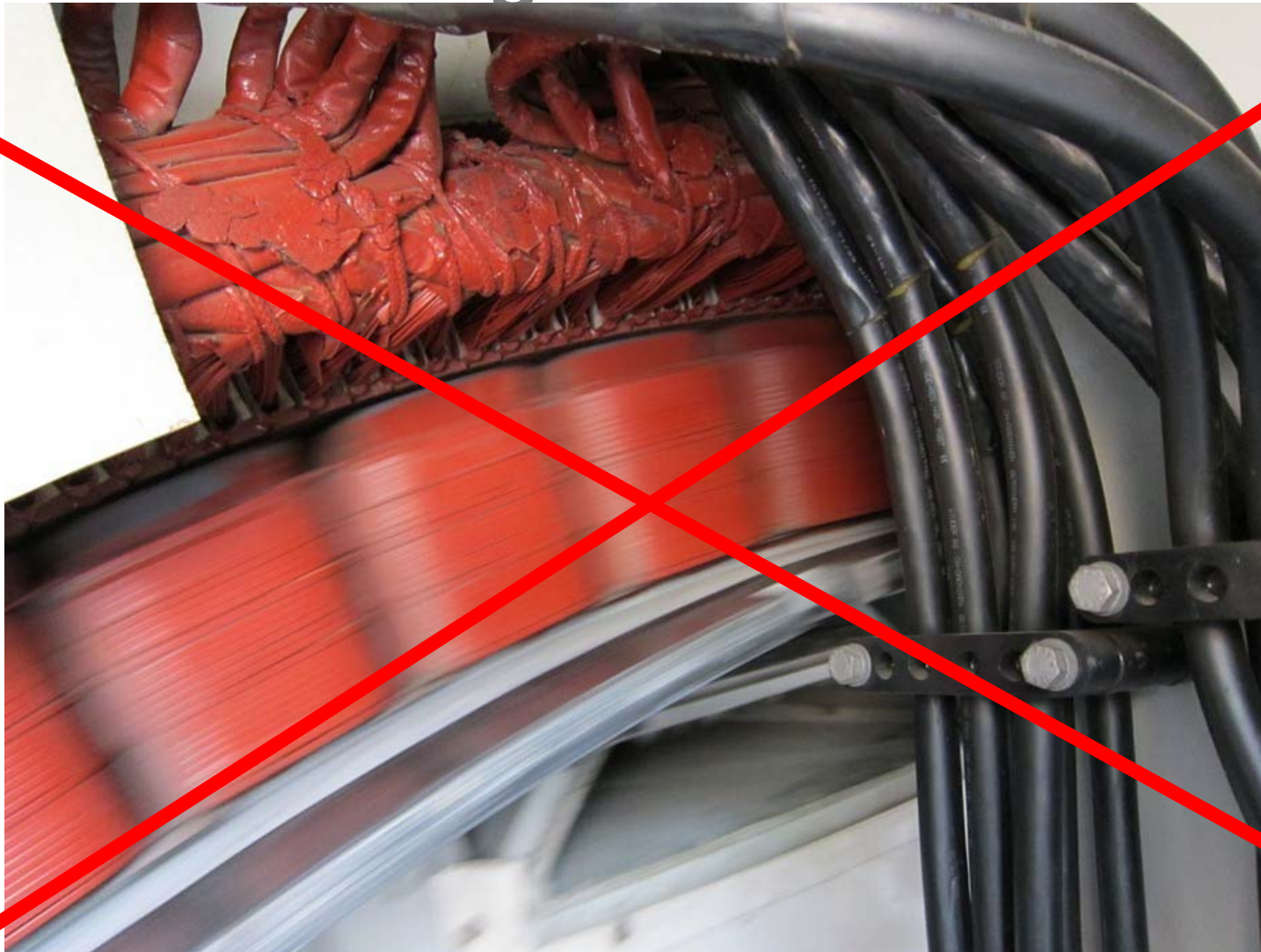
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Lee Chi Kwan, Liu Heng (The University of Hong Kong)

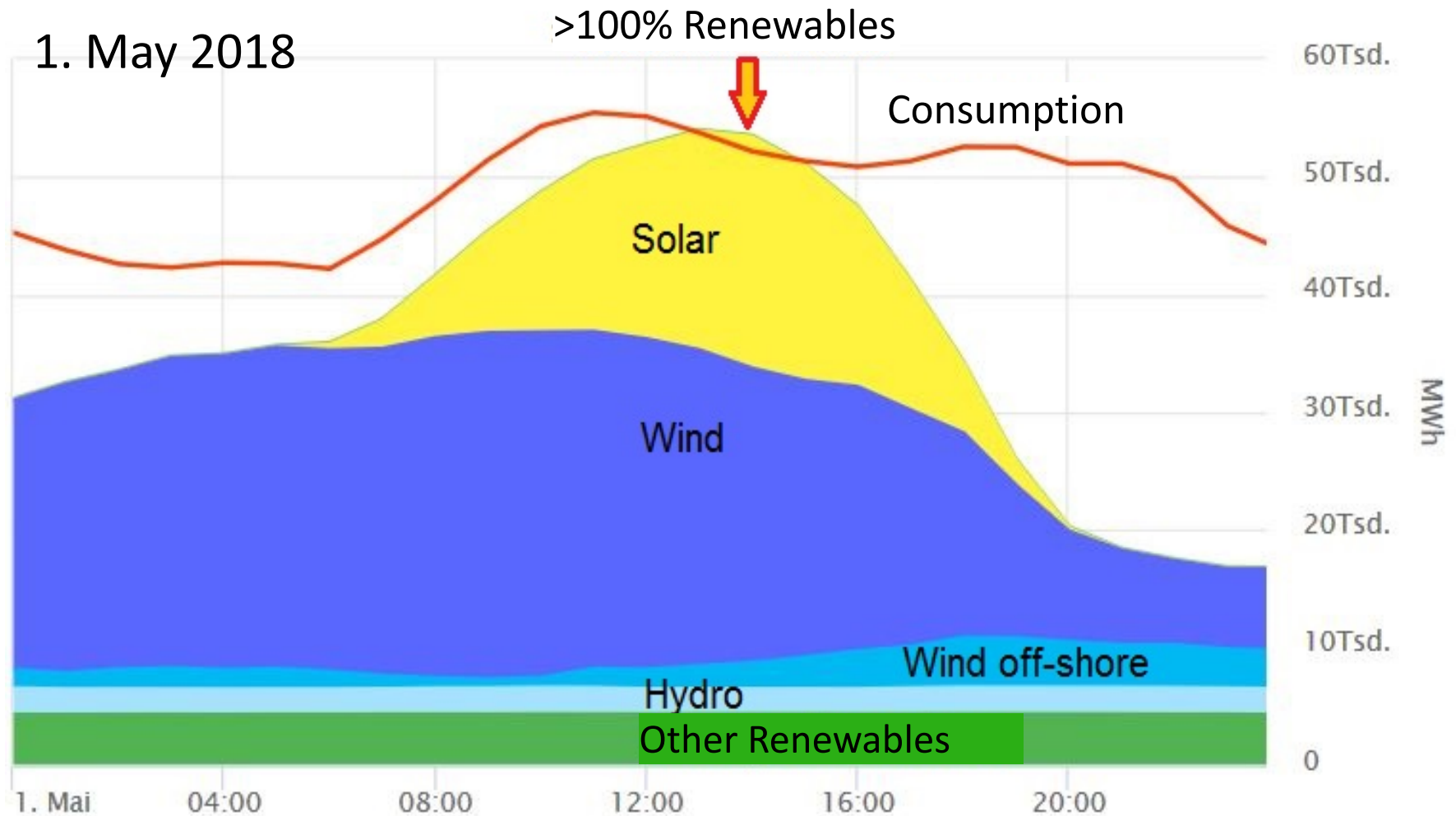


IESC 2018, Cologne, 17.-18. May 2018

# Conventional generators will be missing



# Sometimes 100% RE in the grid

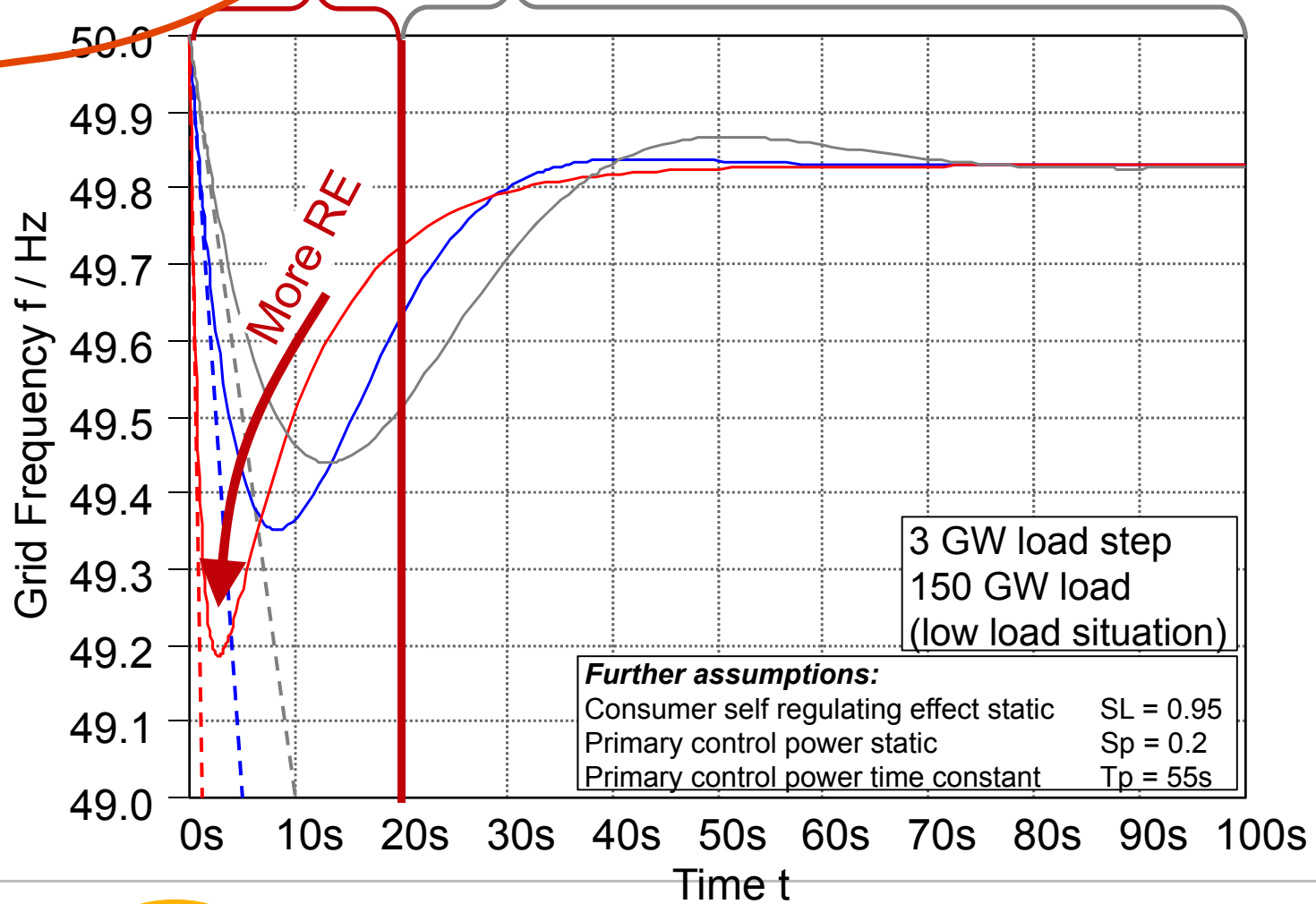


<https://www.smard.de/blueprint/servlet/page/home/marktdaten/>

# Reaction to load step

Instantaneous reaction:  
Virtual inertia with power  
inverters

Primary control

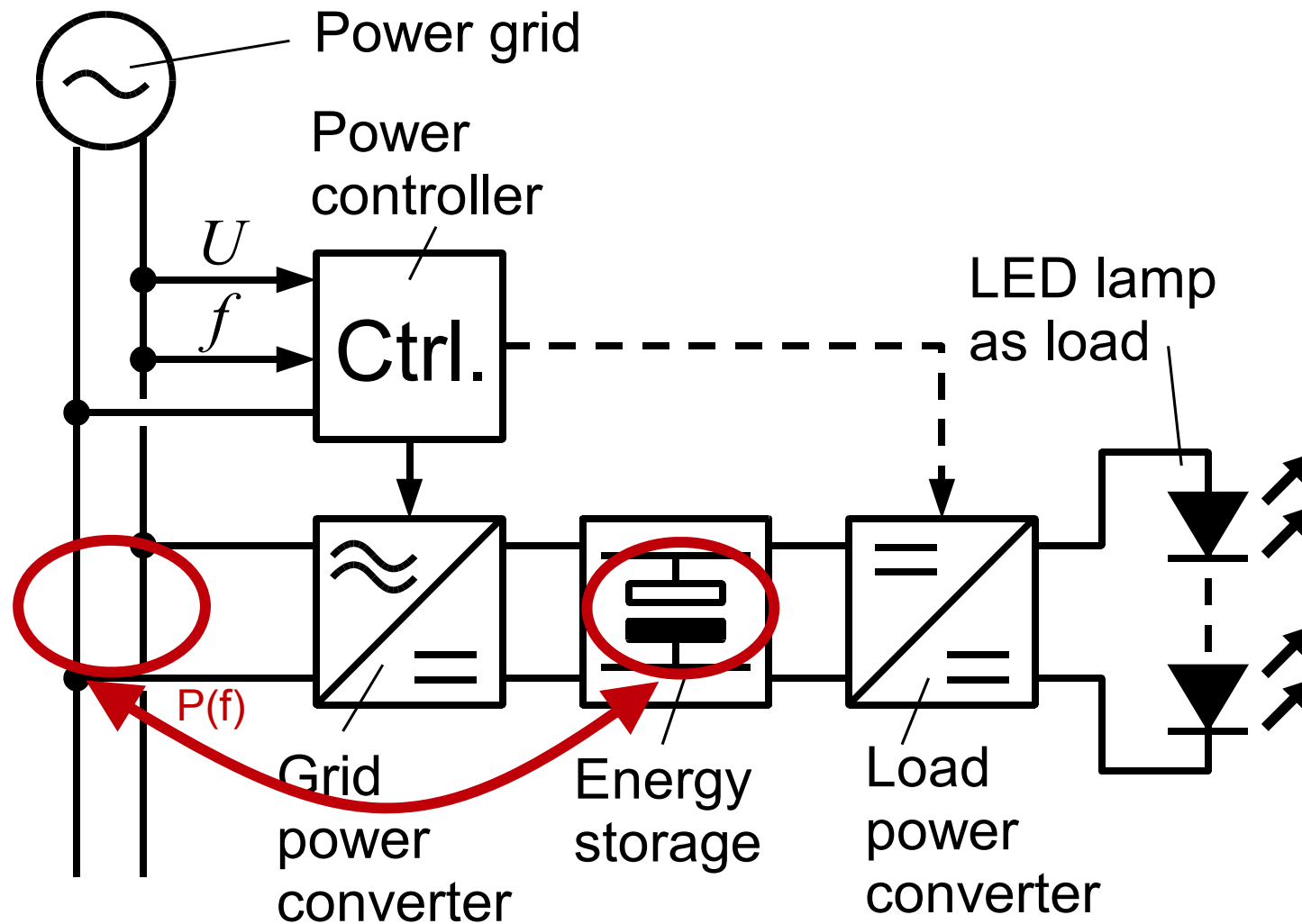


# Virtual Inertia

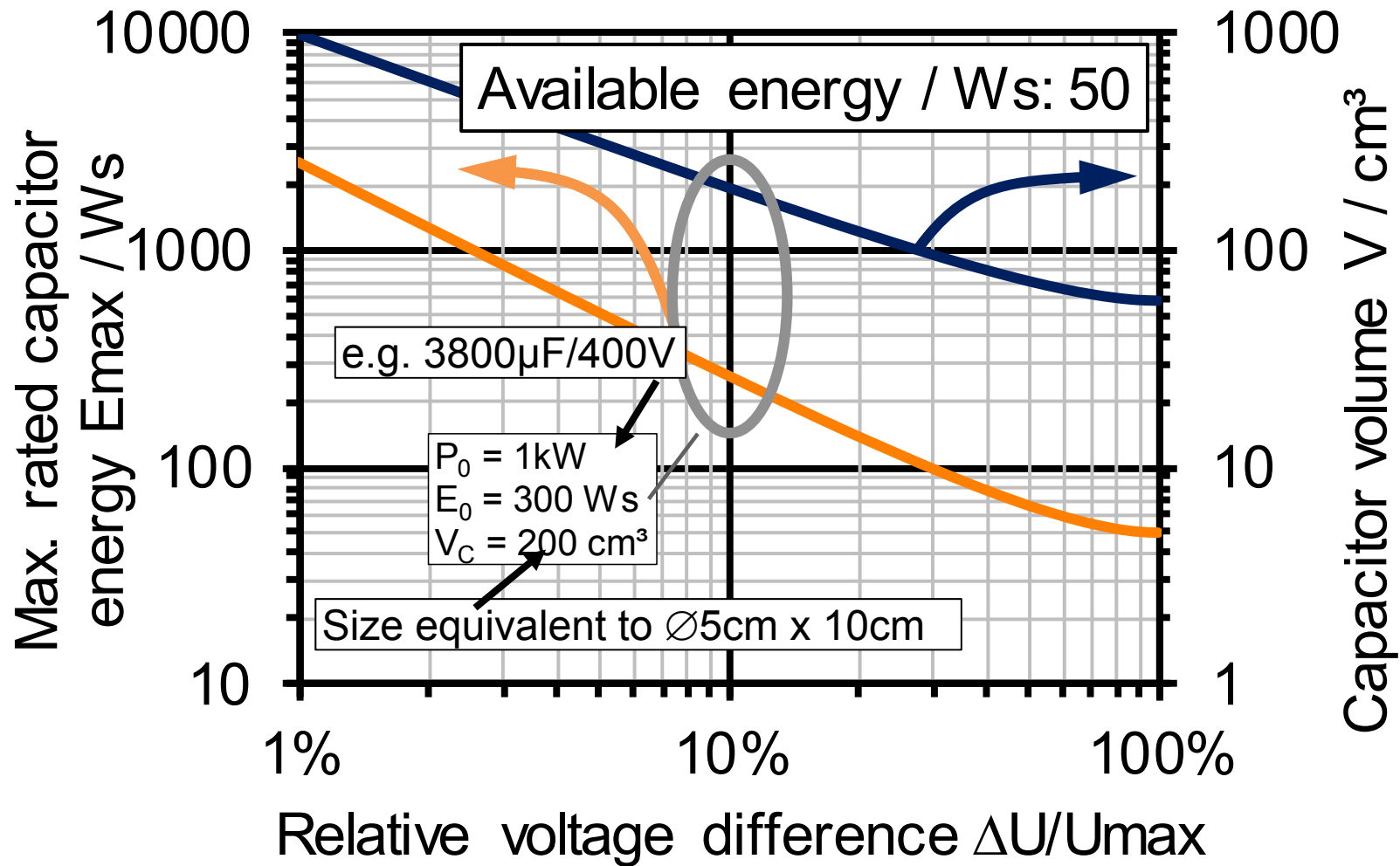




# The idea: Use capacitor in power supply



# Needed capacitor size

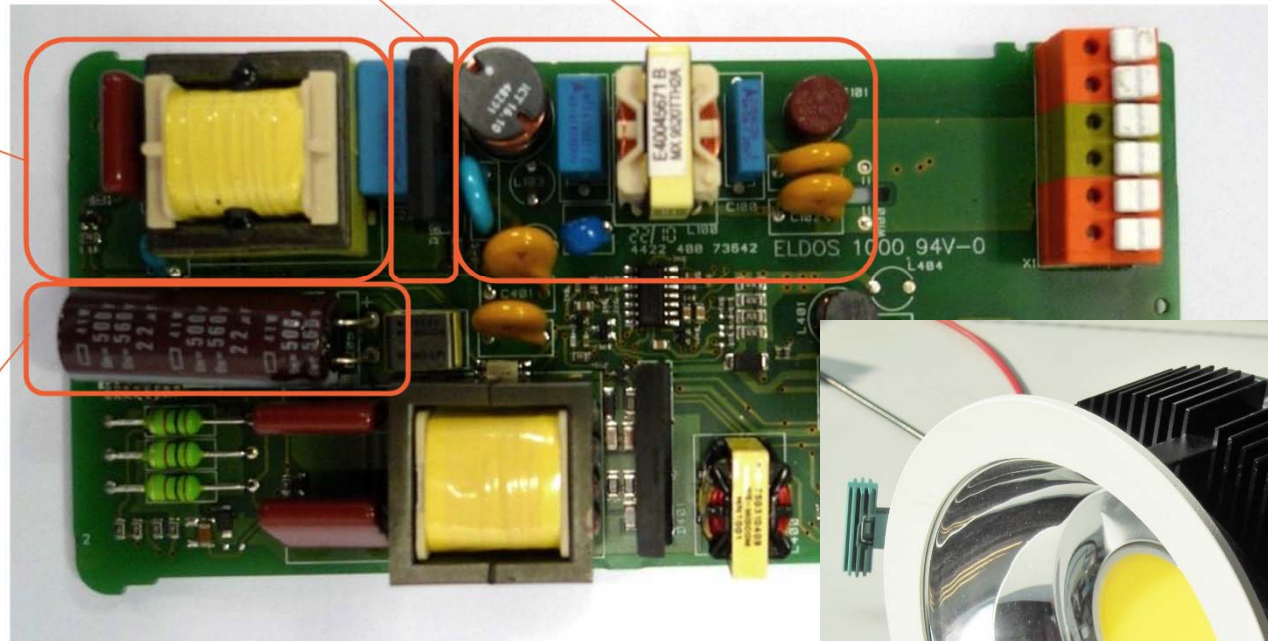


# LED driver and Lamp

AC part =  Bridge rectifier      Input Filter

Power factor correction

Storage electrolytic capacitor

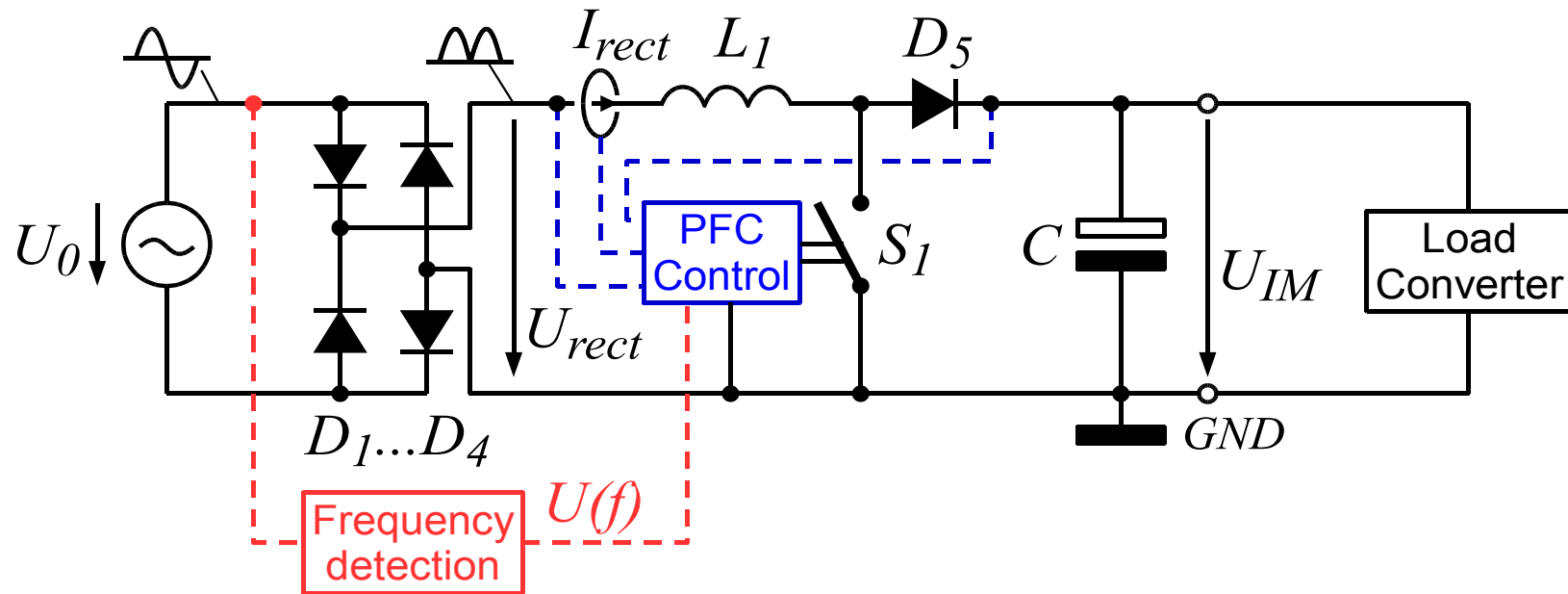


Philips Fortimo LED driver, up to 45 W





# General control circuit



# Virtual inertia with power converters

Use intermediate voltage capacitor:

- Existing hardware can be used
- Control easily adapted

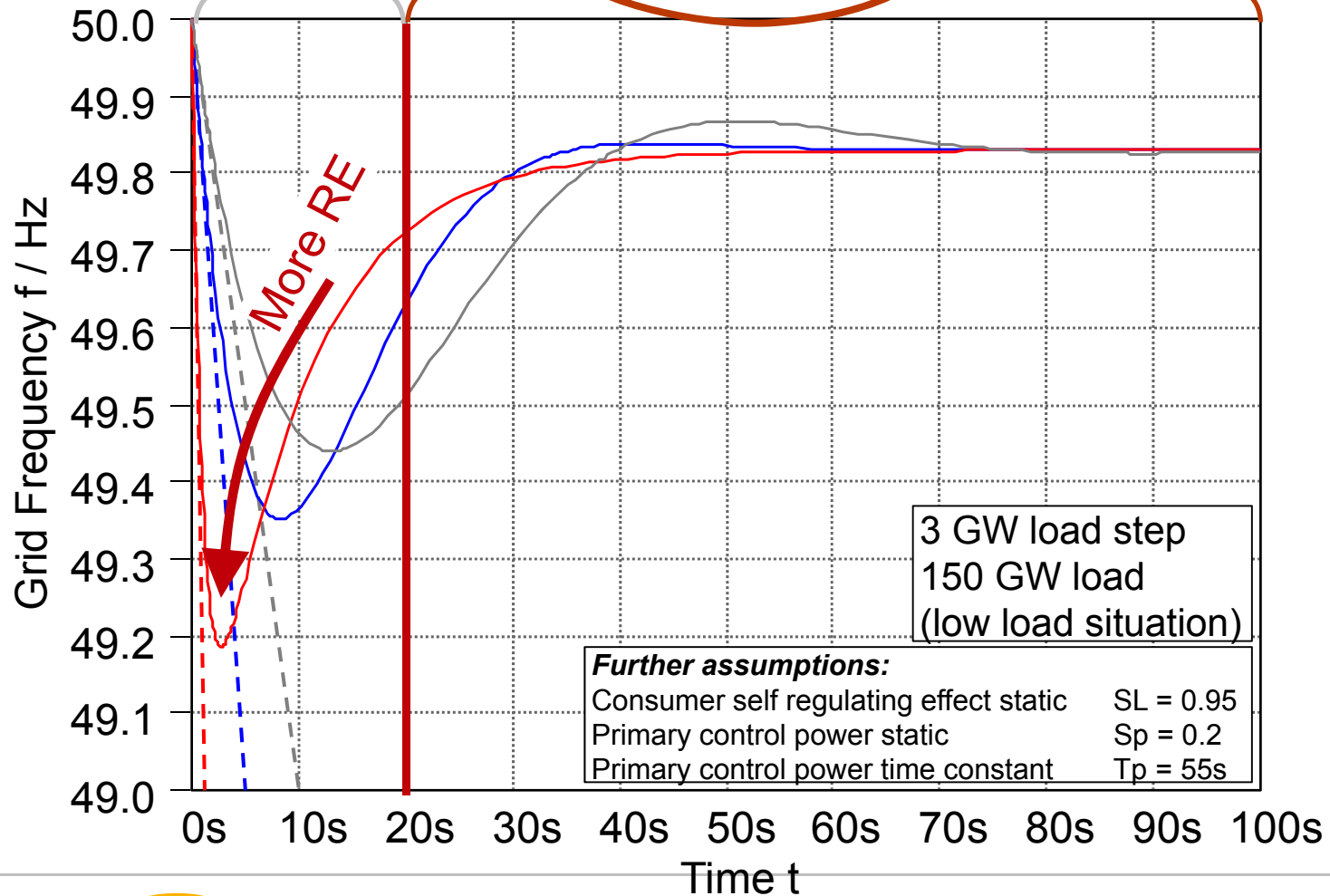
# Primary Control



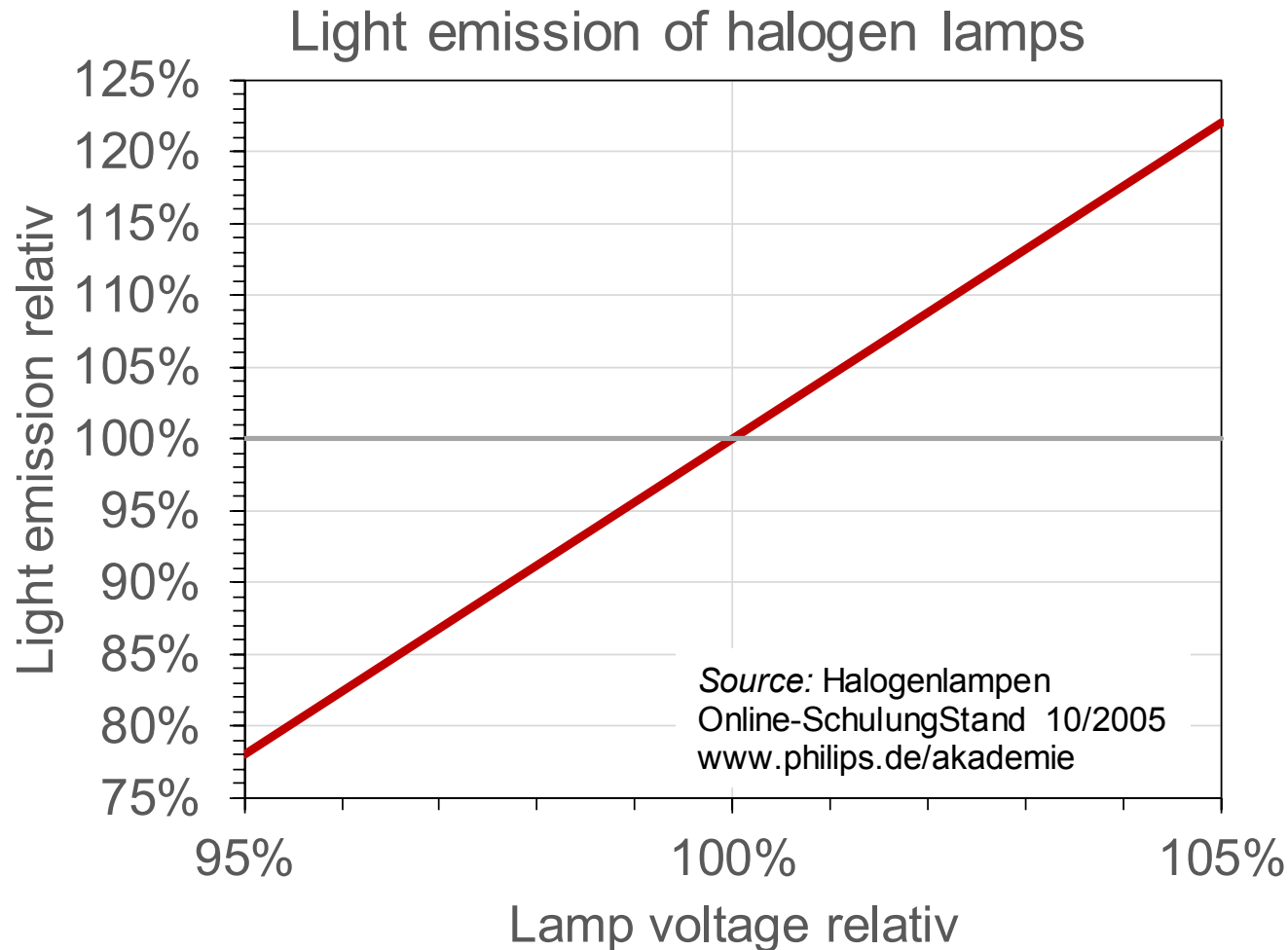
# Reaction to load step

Instantaneous reaction:  
*Virtual inertia with power  
inverters*

Primary control:  
*Use LED brightness*



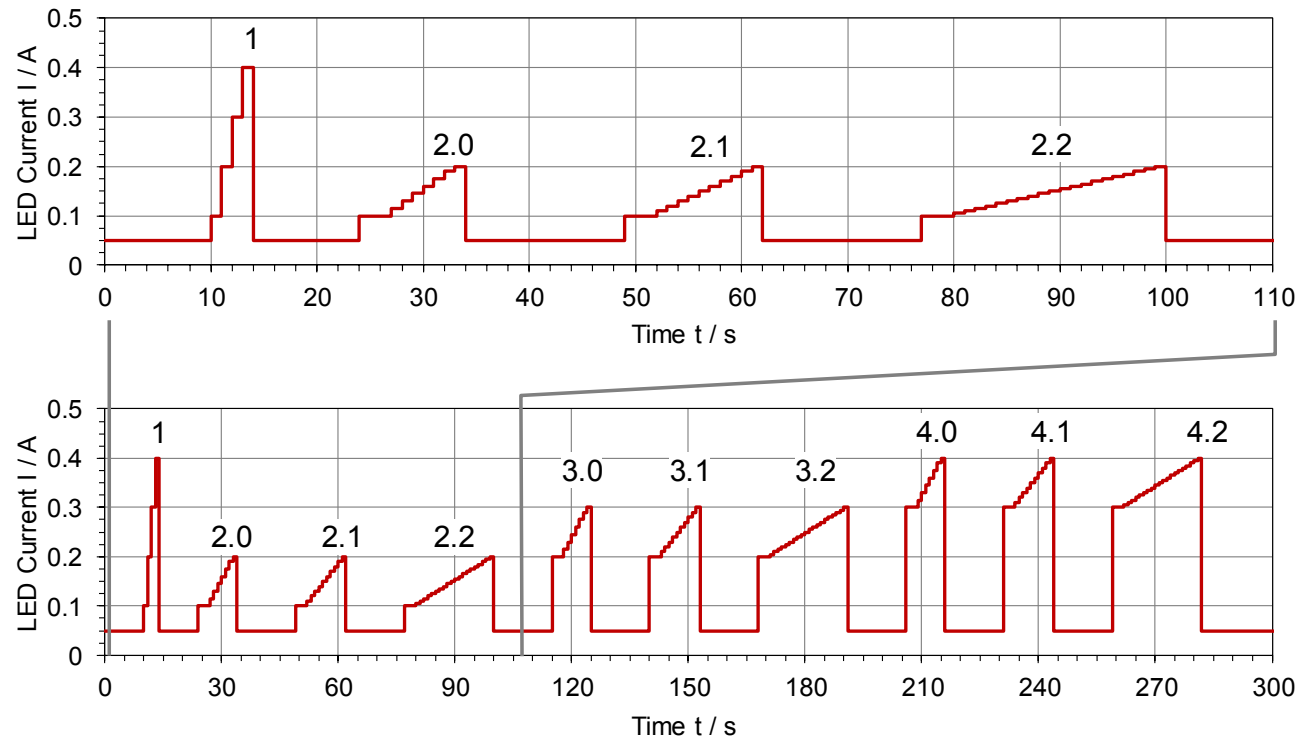
# Existing brightness variation



- Grid voltage range: +/-10%
- Light bulbs: much more than +/-20% light emission range



# Brightness perception experiment



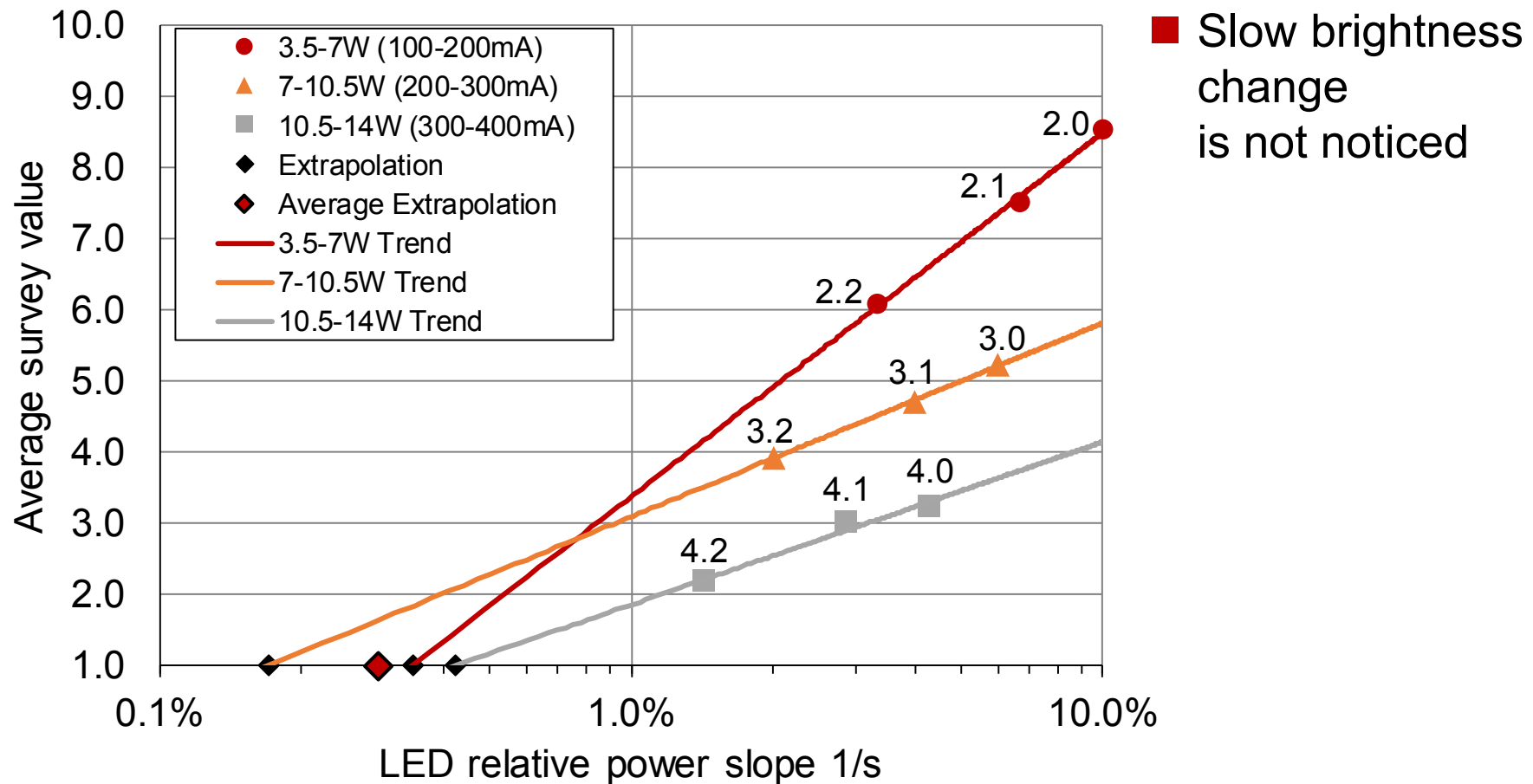
**Idea:**

- Slow brightness change is not noticed

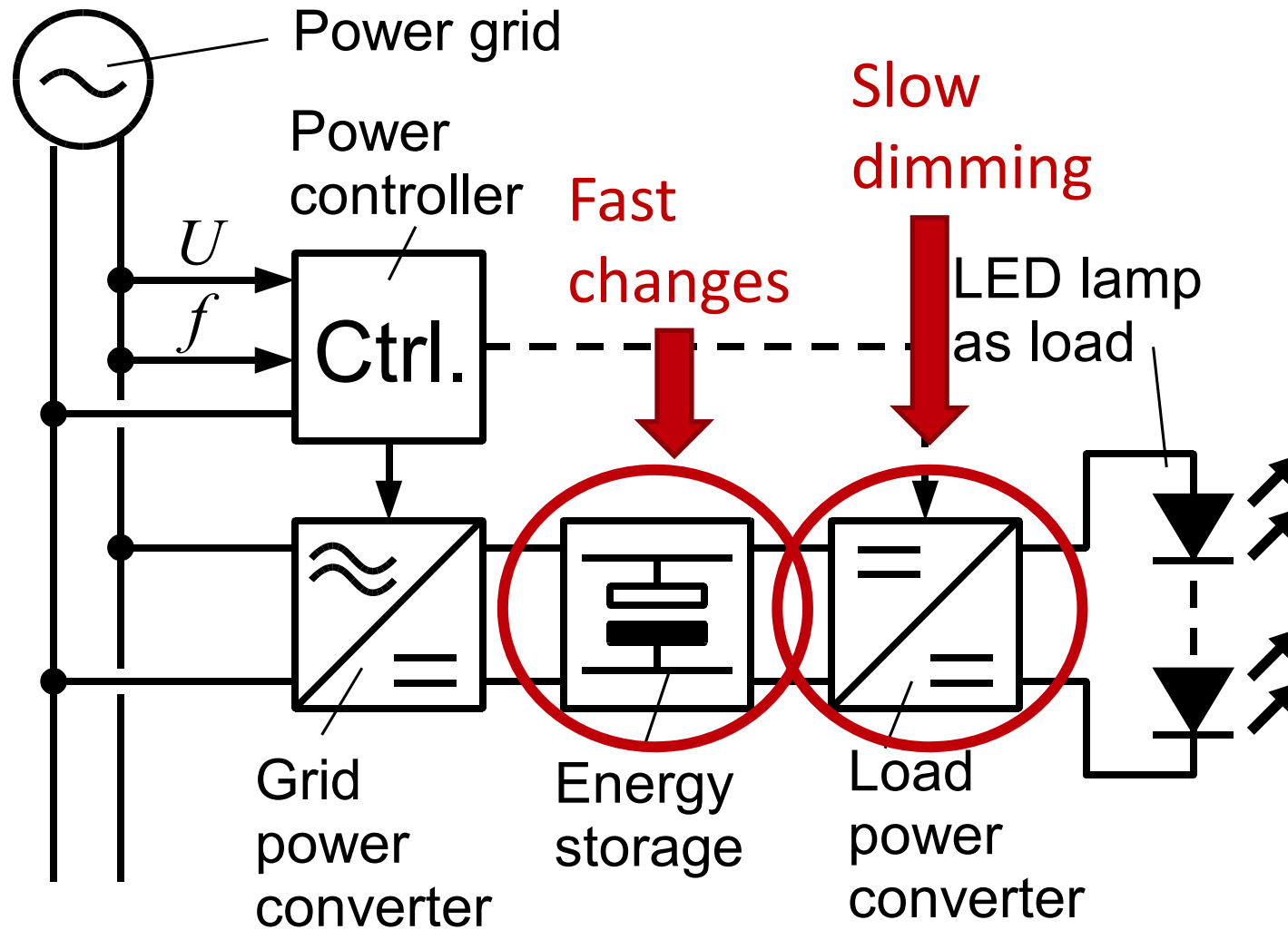


Light shielded chamber

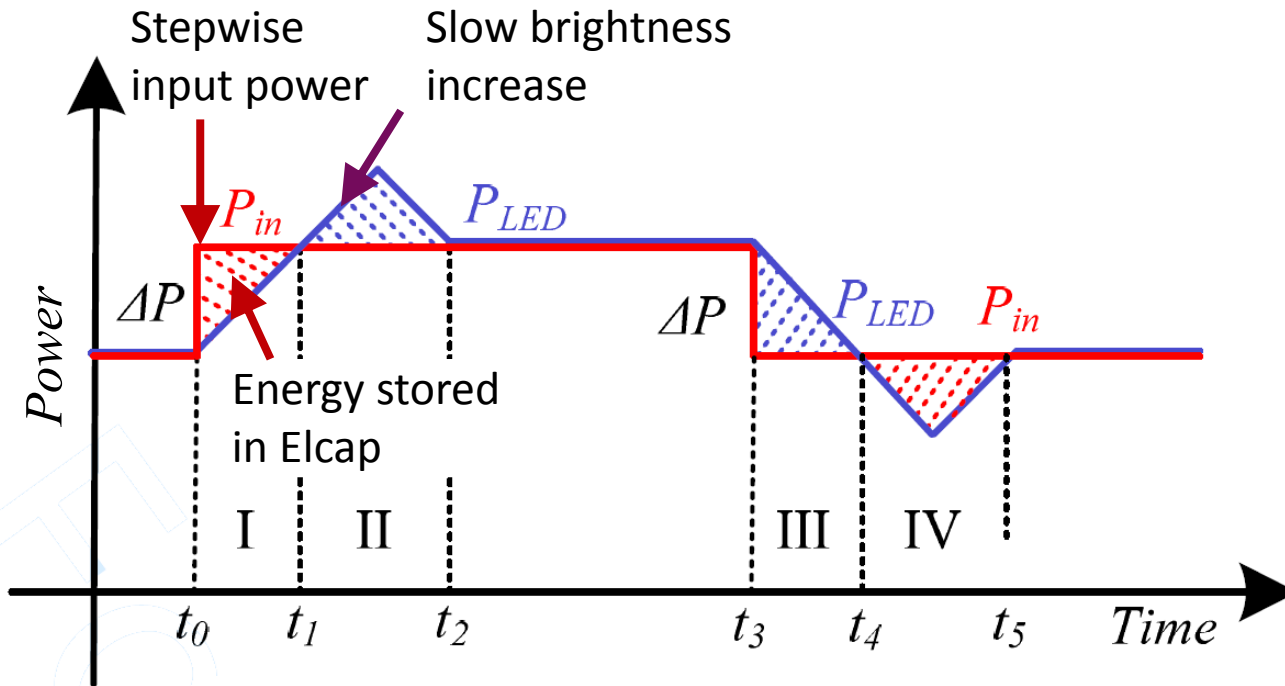
# Perception limit curve



# Control structure



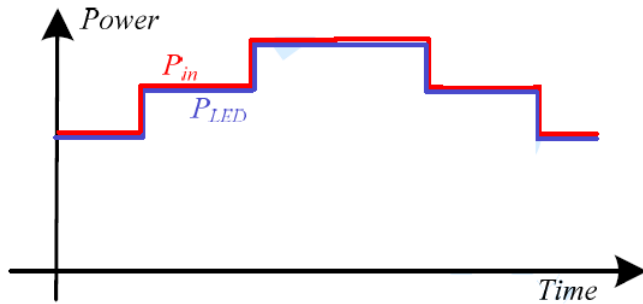
# Power slope



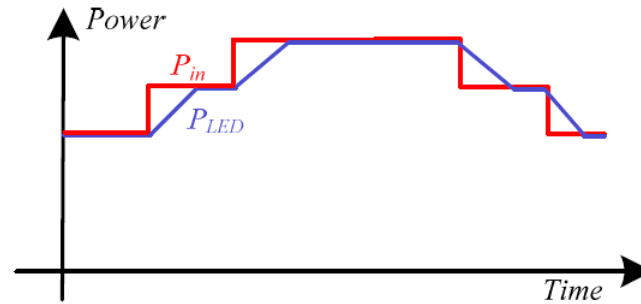
- Power step size dependent on elcap size
- Up to 10% power step manageable

# Final perception experiment

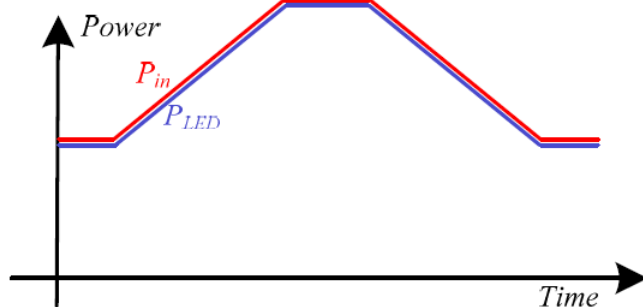
Test I: Step change without HVP



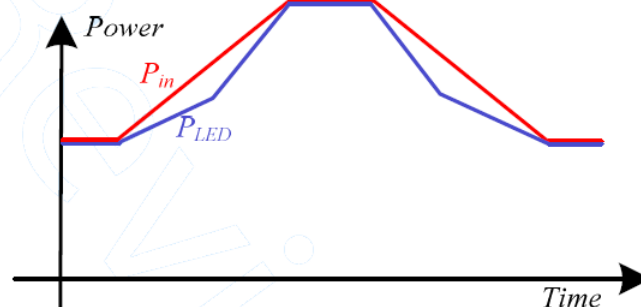
Test II: Step change with HVP



Test III: Slop change without HVP

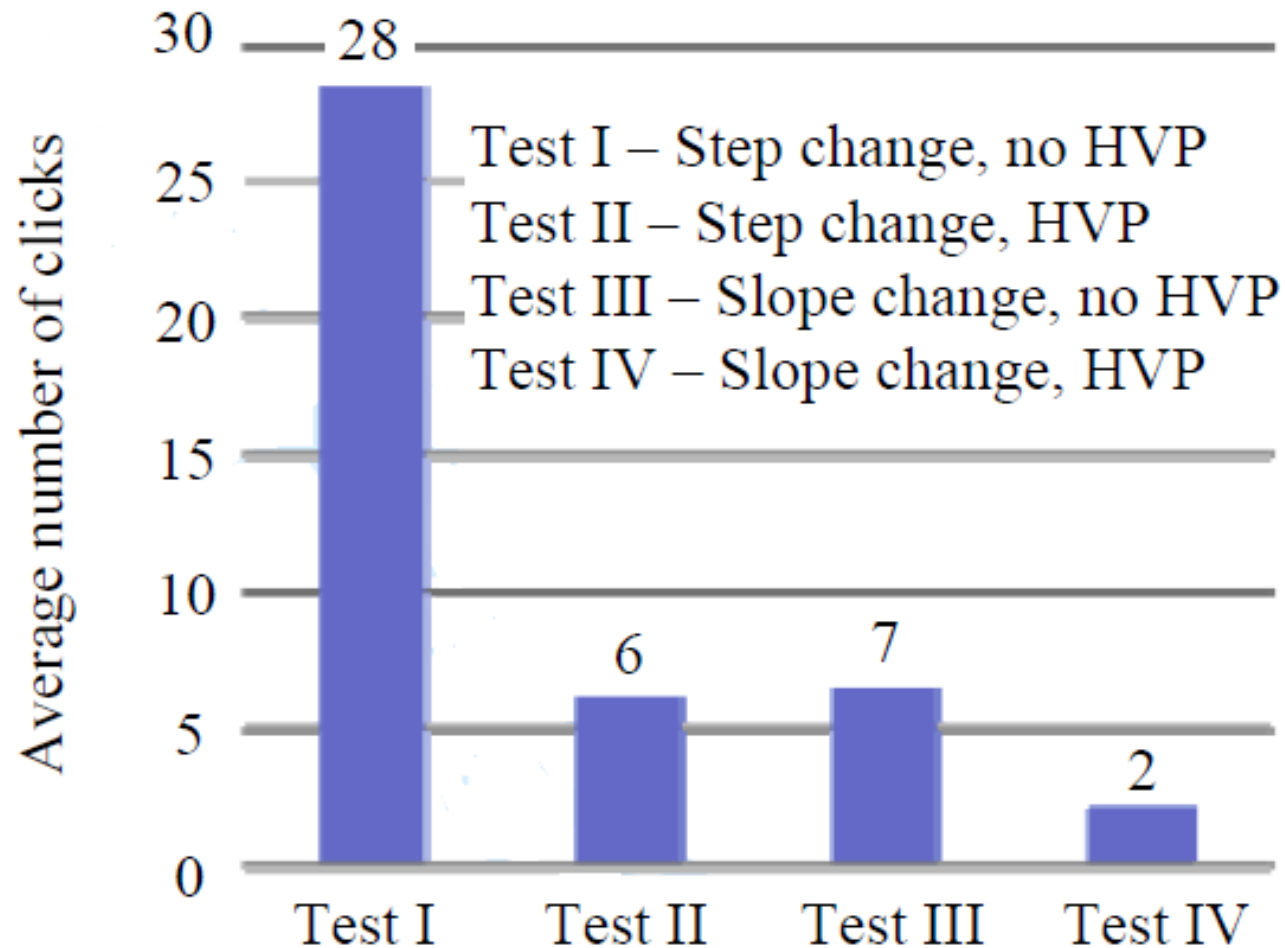


Test IV: Slop change with HVP





# Results of the final survey



# Conclusion

LED-lamps can be used for grid control because

- *Slow brightness changes*  
are not noticed
  - *Fast power changes*  
are taken over by intermediate voltage elcap
- ➔ Up to 2% power steps can be mitigated

# Contact

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