Subtask B: Lighting Controls: Technological Aspects

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ISES + IEA SHC
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Lighting control: the upper-level of the narrative of lighting design

Beyond energy efficient light sources: the next step
Participants to subtask B

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5 reports on their way...
Survey on context of controls of lighting and shading

Interviews of more than 100 professionals in Denmark, China, Belgium, Norway, Poland, Austria, Sweden, Italy and Germany

On topics related to:

- Energy aspects (reduction of lighting consumption, benefits of shading...)
- Operational aspects (maintenance, commissioning, etc.)
- Desire from owners (future proof, costs, etc.)
- Occupant control (automatic vs manual, override, etc.)
- Consequences on occupant comfort
- Control functionalities (open source?; connected to BMS)
- Other issues...
Survey on context of controls of lighting and shading

Results so far:

1. Contribution to reduce lighting electricity consumption
2. Robustness and warranty
3. Easy Commissioning (and re-commissioning)
4. Standardized solutions
5. Investment costs and running costs
6. Simplicity of operation
7. Override (shading). Manual control
8. Individual task / ambient controls
9. Glare control from windows
10. Concern for well-being of occupants
11. Future proof
12. Compatibility with BMS, HVAC
13. Wireless – Internet gateway
Review of systems

Review of « strategies »

Reducing energy use through
- Lighting only when spaces are occupied (occupancy sensors) or time based (fixed, adjustable)
- Dimming of switching-off lights as a function of daylight
- Constant light output over duration of use
- Shading for visual comfort (protection from glare) and possible reduction of heat gains

Architecture
- Centralized / localized / mesh
- Closed loop / open loop / Internet of things (IoT)

Mapping of solutions as a fonction of the energy saving potential
Solutions and trends

Review of market structure and drivers
Residential and non-residential
Dimming vs on-off (system consumption?)
External / internal shading
Motorized / non-motorized shading
Security issues

Lighting control options
Ceiling lighting options (per lines or zones)
Task lighting per workplace
Solutions and trends

Strategies for communication (hardware)

Wired / wireless
Analog, phase dimming, DALI, DMX, KNX, Bluetooth, Zigbee, etc.
Centralized Gateway to Internet
Communication protocols
POE (Power Over Ethernet)
DC Powered (48 V)
Battery-less sensors and switches
Geolocation chips
(commissioning)
Suppression of AC/DC converters for each luminaires
Use centralized high efficiency converters (0.5 KW to 2KW, eff 95%)
Use plug ad play ceiling lights without need of electricians
Possible link to Photovoltaic power supply.
Will benefit of cheap components for electric automobile industry (48V DC)
Gateway to internet through wireless data exchange. (chip on light engine)

*On-going tasks: standardization, certification, safety issues, etc.*
Solutions and trends

Strategies for communication (software)

Protocols: frequency, Issues with distance, indoor/outdoor, energy use, data rate, triggering, latency, size, open application, etc.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Wi-Fi</th>
<th>Z-Wave</th>
<th>ZigBee</th>
<th>Thread</th>
<th>BLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocols</td>
<td>IEEE</td>
<td>IEEE</td>
<td>IEEE</td>
<td>IEEE</td>
<td>IEEE</td>
</tr>
<tr>
<td>Frequency Band</td>
<td>2.4 GHz</td>
<td>900 MHz*</td>
<td>2.4 GHz</td>
<td>2.4 GHz</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>Maximum Range (m)</td>
<td>100 m</td>
<td>30 – 100 m</td>
<td>10 – 100 m</td>
<td>10 – 100 m</td>
<td>30 m</td>
</tr>
<tr>
<td>Maximum Data Rate (kbps)</td>
<td>54 kbps</td>
<td>40 – 100 kbps</td>
<td>250 kbps</td>
<td>250 kbps</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td>Alliance</td>
<td>Wi-Fi Alliance</td>
<td>Z-Wave Alliance</td>
<td>ZigBee Alliance</td>
<td>Thread Group</td>
<td>BLE</td>
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<tr>
<td>Web site coverage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Power efficient</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High data bandwidth</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
### Table: Analysis of lighting controls in relation with possible Value Proposition.

<table>
<thead>
<tr>
<th>Reduces lighting electricity use</th>
<th>Lighting control as a source of “Value Creation” (offering new business opportunities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes lighting control more appropriate for occupants easier for occupants</td>
<td>Control specific lamps (wall washers, task, et.)</td>
</tr>
<tr>
<td>Make lighting control easier for occupants</td>
<td>New sensors and sensor location</td>
</tr>
<tr>
<td>Make change of affectation of spaces easier (size of meeting rooms, size of offices, etc.)</td>
<td>Open loop / closed loop</td>
</tr>
<tr>
<td>Lighting controls when shades are pulled down,</td>
<td>Propose a user-friendly, simple and attractive interface</td>
</tr>
<tr>
<td>Reduce glare from windows with shading</td>
<td>Propose a full flexible module for control, beyond lighting (communication, displays, etc.)</td>
</tr>
<tr>
<td>Simplify closing of a house (global control)</td>
<td>Propose geolocalization services with lighting (LiFi)</td>
</tr>
<tr>
<td>Global warming increases risks of overheating, quality shading is necessary for more and more days</td>
<td>Easy commissioning and re-commissioning</td>
</tr>
<tr>
<td>Obstacles in deployment of DC powersupplies.</td>
<td>Future proof (system which could adapt to evolutions of technology over time): Updating through the internet: new software</td>
</tr>
<tr>
<td>Reburishments</td>
<td>Interoperability (linked to other control systems and services, simplifies management, data, etc.)</td>
</tr>
<tr>
<td>Make a house warmer during cold sunny days</td>
<td>Make house cooler during warm sunny days</td>
</tr>
<tr>
<td>Remote control from outside the building (facility management, user comfort)</td>
<td>Make a house warmer during cold sunny days</td>
</tr>
<tr>
<td>Anticipation of overheating: shading controls need to be more predictive and smarter (more data to collect)</td>
<td>Make house cooler during warm sunny days</td>
</tr>
<tr>
<td>Flexibility can be related to future proof: update of systems</td>
<td>Possibility to re-program the controls</td>
</tr>
</tbody>
</table>
User interfaces

Categories: naalog, figital, hybrid

Components

Trends

Link to energy savings,

Combined control of lighting and daylighting

Consequence on possible occupant satisfaction
Integration and Optimization of Daylight and Electric Lighting

Subtask B – Section 5 – User Interface
Draft document August 2020

Figure 2 Example of UI: Phillips Hue App interface – from left: 1) different light by slider, and currently set sources with their intensity shown t color 2) Selection of lighting scenes 3) A color control over lighting in selected room “Front Room”.

Figure 3 Example of UI: Ikea Smart Home App interface – from left: 1) Dimming of rooms and specific light sources. 2) Setting dynamic control using clock and calendar. 3) Setting dynamic control over lighting by defining scenes.

Examples of Power symbols and relevant sources
Global outcome / issues

- Effect on life time
- Reduced life time of lighting components (plug and play)
- Maintainance of flux output
- Holistic approach of costs: labor costs vs product costs
- Commissioning speed influencing technological choices
Review of Standards

• Relevant standards

• New standards being developed

• Need for standards.
Virtual reality (VR) based Decision Guide

Interactive on-line tool showing examples of solutions being proposed and tested

(Little demo)
Three channels demo, with electric power monitored.

To link lighting control and lighting effects and facilitate understanding of optimal power management.