International Energy Agency

4E Solid State Lighting Annex

Introduction

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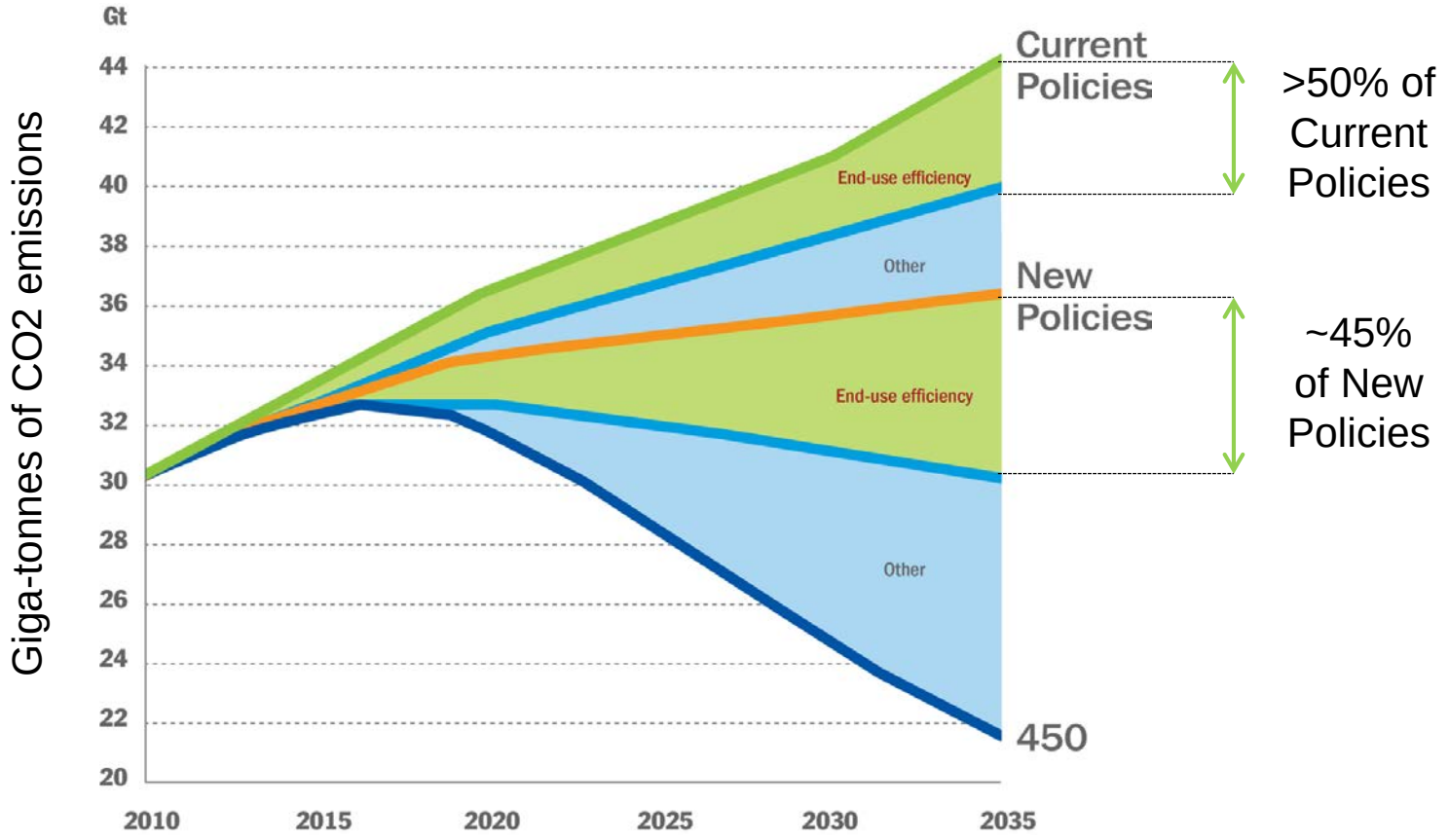
Context – Lighting the World with LEDs

- Lighting consumed 15 % of the total electricity consumption in 2015, or 2940 TWh
- The electricity needed to run the lights contributed with 1.6 Gt of CO_2 emissions
- > 1,0 bn people lack access to electricity and thus electric lighting
- LED technology is an excellent solution to these problems, and can reduce electricity consumption for light by over 50%

Importance of End-use Efficiency: IEA Estimates to 2035

Lighting is one of the key technologies offering end use energy efficiency (but not the only one)



IEA Implementing Agreement: Energy Efficient End-use Equipment

4E EXECUTIVE COMMITTEE
Management of 4E

→ **4E PROJECTS**

ELECTRIC MOTOR SYSTEMS ANNEX
Encourages alignment on policies proven to be effective for motors and motor systems

SOLID STATE LIGHTING ANNEX
Develops tools, test methods and policies to ensure high quality LED lighting

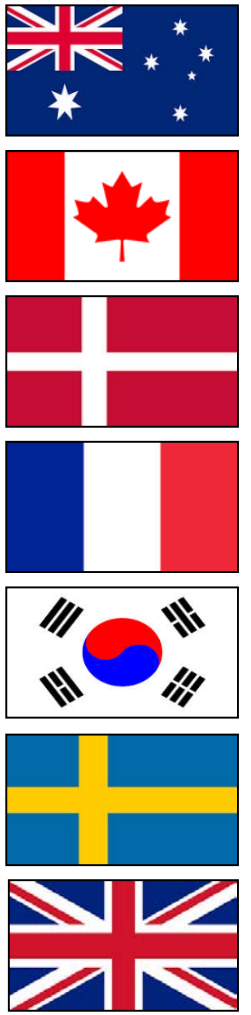
ELECTRONIC DEVICES AND NETWORKS ANNEX
Monitors the energy consumed by connected devices and their networks and identifies government policies to minimise energy consumption

POWER ELECTRONIC AND CONVERTER TECHNOLOGY ANNEX
Co-ordinating internationally acceptable approaches to promote WBG-based power electronics

Focus today on the SSL Annex

SSL Annex Overview

- Governments initiated the SSL Annex in 2010 with a goal to increase the confidence of the solid state lighting technology in the marketplace.
- Collaboration between countries - working together can achieve more than working alone by combining strengths and expertise to develop:
  - Tools to assess the performance of SSL,
  - Information assisting formation of energy-efficient lighting policies, and
  - Support for use of harmonised test methods and laboratory accreditation
- Work is conducted by country appointed experts and labs under the direction of participating governments; Operating agents support the work of the experts and governments.
- Currently seven member countries: Australia, Canada, Denmark, France, Korea, Sweden and UK.



SSL Annex Work Plan (2019-2024)

Task 1. Human Centric Lighting, Health and Comfort

Updating the health study from the first term; human health issues, interpretation and guidance on setting requirements on health-related aspects

Task 2. Lifetime of SSL Lamps and Luminaires

Review and conduct accelerated aging tests; predictive tests; durability testing addressing high temperature operation; check the quality of the driver and its impact on lifetime

Task 3. Lighting and the Environment

Updating the environmental study from the first term; LCA's and disposal/recycling issues while also considering wider environmental impacts of artificial light

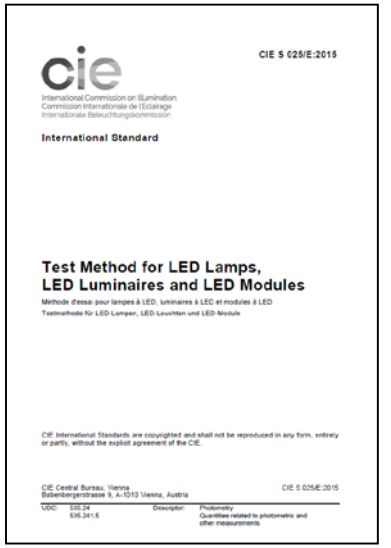
Task 4. Interlaboratory Comparison for Temporal Light Modulation

Develop a proficiency test for accreditation to IEC TR 61547-1 for P_{st}^{LM} and IEC TR 63158 for SVM. Labs demonstrate competence through the IC, building on our previous two global IC's

SSL Annex Work Plan (2019-2024)

Task 5. Test Method Assessment

Review requirements and the standards that underpin them to assess the accuracy and cost of conducting testing of SSL products; comment on test methods to policy-makers and standardisation bodies



Task 6. Quality and Performance Tiers

Maintain the SSL Annex's three levels of quality and performance tiers for the most popular LED lamps and luminaires in the market

Task 7. Smart Solid-State Lighting

Classify energy consumption (including standby power) of smart features in lamps, luminaires and lighting systems; note: lighting systems may be studied, depending on the development in the work; coordinate with EDNA

Task 8. SSL Annex Product Database

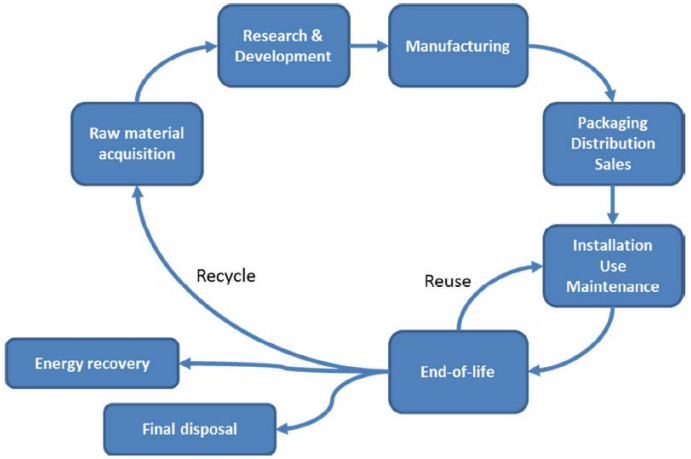
Maintain the internal benchmarking product database to enable member countries to share performance data and test results for LED lamps and luminaires

Project Example: Test Method Assessment

- Review of the metrics and requirements set-out in existing regulations (as well as those not yet included) and the measurement standards that underpin those requirements to:
  - determine the accuracy and cost of conducting testing of SSL products.
  - Identify gaps in available standards that may hinder effective regulation. For example:
    - Need for more standard guidance on dimming
    - Updated colour quality standards to better address LED lighting
- Provide feedback to standardisation bodies, proposing:
  - New standards
  - Raising issues with accuracy or cost of existing standards
- Provide feedback to SSL Annex countries

Project Example: Lighting and the Environment

- 2014 – Lifecycle Assessment Report -
  - literature study of available information on life-cycle assessment impacts of LED systems compared to conventional lighting systems. https://ssl.iea-4e.org/health-environment



- Aim to update in 2020 with broader scope including:
  - Environmental impacts of outdoor lighting –
    - light pollution
    - stray light
    - blue light diffusion
    - impact on flora and fauna
  - Update LCA studies and include consideration of both indoor and outdoor lighting
  - End of life disposal issues
  - Examine options to include social and sociological aspects of lighting products throughout the lifecycle

Project Example: Quality and Performance Tiers

- SSL Annex Experts established and maintain quality and performance tiers for common LED lamps and luminaires
- Three tiers (levels), based on analysis of available products on the global market
- Policy-makers and programme managers can use these criteria when drafting policy or procurement requirements – governments, utilities, municipalities, green investment funds
- They facilitate the harmonisation of requirements, lowering trade barriers and costs

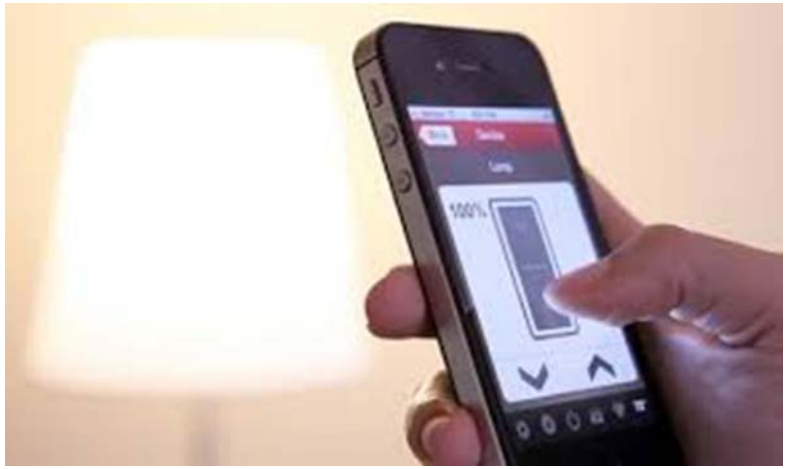
Project Example: Interlaboratory Comparisons 2013, 2017, 2020

- Identified need for increased test laboratory capacity for consistent, accredited testing of LEDs.
  - Comparison measurement of equipment
  - Proficiency testing for SSL testing accreditation programs
- IC2013 http://ssl.iea-4e.org/task-2-ssl-testing/2013-ic-final-report - comparison testing using integrating spheres.
- IC 2017 Interlaboratory Comparison of Goniophotometer Measurements
  - To provide comparison of measurements by goniophotometers, for LED luminaires (and LED lamps) as a technical study
  - 43 goniophotometers across 37 laboratories in 18 countries
- IC 2020 Interlaboratory Comparison for Temporal Light Modulation
  - To promote a harmonised and effective global proficiency test for temporal light modulation (TLM), focusing on IEC TR 61547-1 (short-term light modulation (PstLM)) & IEC TR 63158 (stroboscopic visibility measure (SVM))

Project Example: Smart lamps: New Features impact the energy use

Investigation of energy-related impact of some new features including:

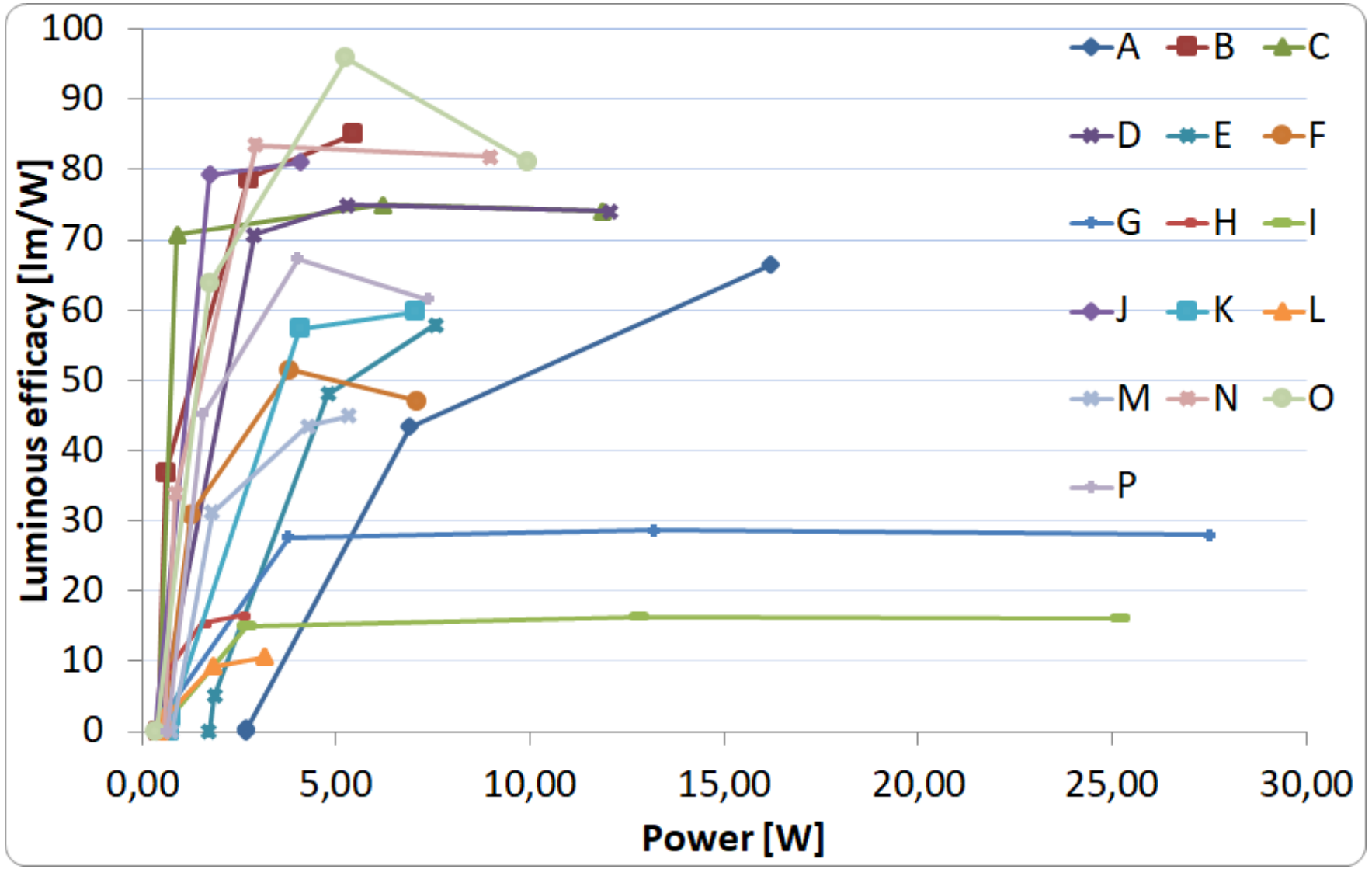
- User welfare
  - Wireless control (on/off, dimming, colour)
  - Colour tunability
- Product functions
  - Prolonging life
  - Active thermal control
  - Maintain flux by driver current regulation
- Environment and economy
  - Energy savings by sensors and others



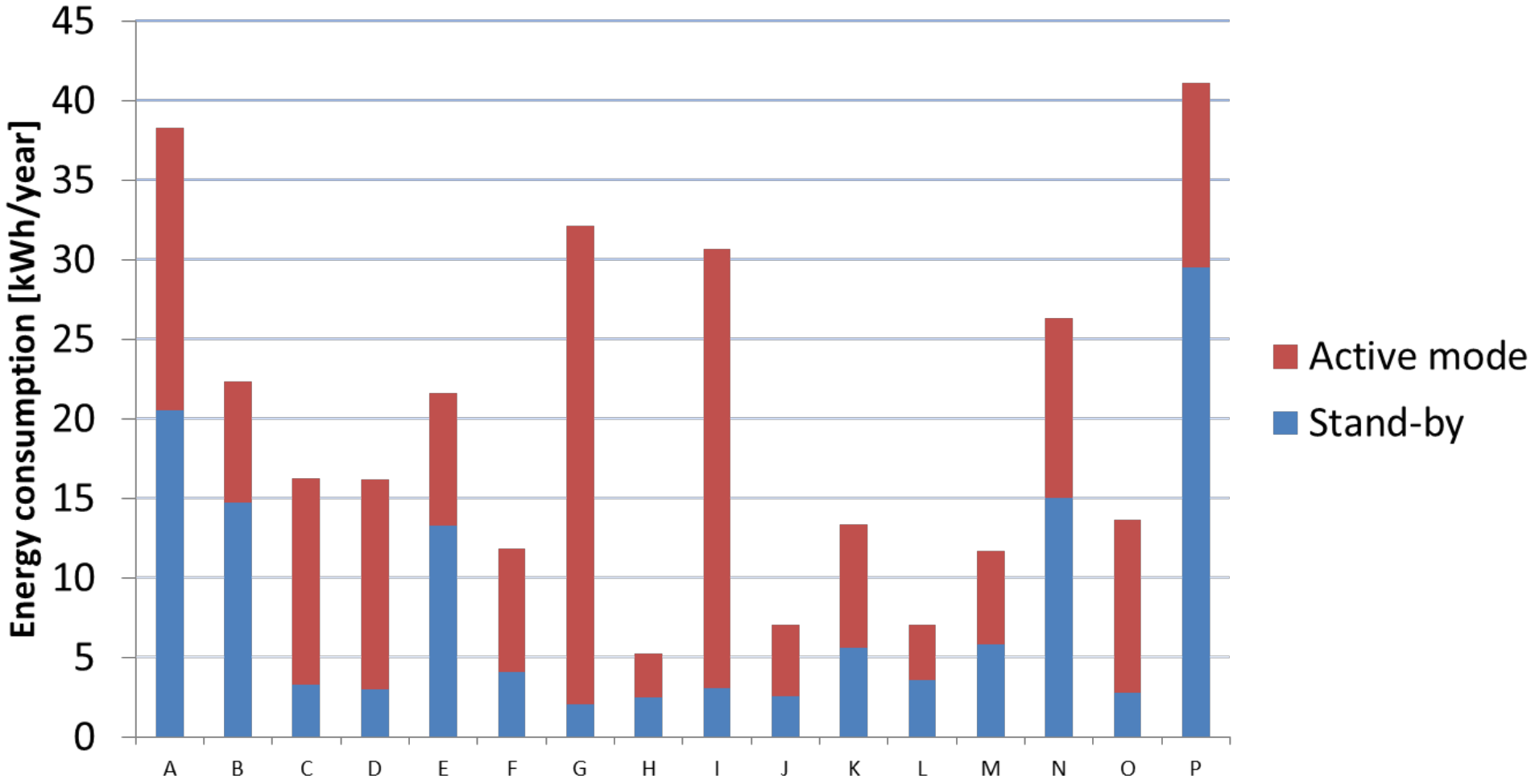
Project Example: Smart Lamp Measurements

- Products tested with integrating spheres and a near-field gonio: E27 lamps and LED-strips
- Colorometric and luminous efficacy measurements:
- White light:
  - 100 %
  - 50 %
  - Lowest possible dimmed setting with light
  - Standby
- Blue, green and red light:
  - 100 %
  - Lowest possible dimmed setting with light
- Report: https://ssl.iea-4e.org/news/stand-by-of-smart-lamps

Smart Lamp – Luminous Efficacy



Energy use per lamp and year: 3h active and 21h standby per day



Stroboscopic Visibility Metric (SVM) Detection Study

- SSL Annex recognition of the importance of understanding flicker detection by people
- Study aimed to address an important gap in the scientific literature on the measurement of levels of temporal light modulation of LED light sources that may affect human health and productivity.
- Objective: to assist decision makers to develop new lighting policy measures and draft regulation
- Six SSL Annex countries funded the research

Stroboscopic Visibility Metric (SVM) Detection Study

- Study launched in November by
  - National Research Council (Canada) and
  - Centre Scientific et Technique du Batiment (France)
- Interim findings issued December, (input to EU regulatory process)
- Additional research has since been conducted, increasing sample size;
- CIE paper and workshop in June 2019 in Washington DC;
- a further peer-reviewed journal paper and Final Report later this year

Thank you

Questions?

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