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# IEA 4E SOLID-STATE LIGHTING ANNEX

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**IEA 4E SSL Annex**

**Metrology for Solid State Lighting**
**NPL, Teddington, UK**
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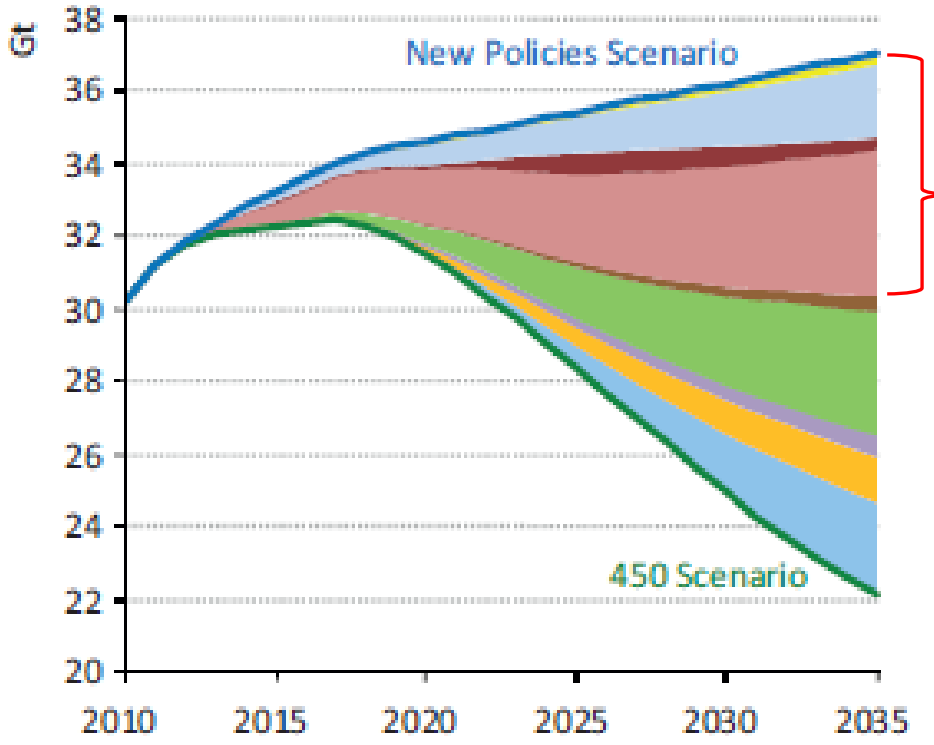
# The Global Context

- Climate change: IPCC 2013 (draft): finds that emission of GHG still increasing, not decreasing
- The probability for meeting the 2°C warming target decreases rapidly
- At present, we are on a trajectory for a 4°C scenario.
- For Governments, energy-efficiency policies are being emphasised now more than ever

# 4 IEA -> the largest source of carbon savings (42% in 2035) is energy efficiency

**Figure 8.7 ▷ Global energy-related $CO_2$ emissions abatement in the 450 Scenario relative to the New Policies Scenario**




| $CO_2$ abatement | 2020 | 2035 |
|---|---|---|
| Activity | 2% | 2% |
| End-use efficiency | 18% | 13% |
| Power plant efficiency | 3% | 2% |
| Electricity savings | 50% | 27% |
| Fuel and technology switching in end-uses | 2% | 3% |
| Renewables | 15% | 23% |
| Biofuels | 2% | 4% |
| Nuclear | 5% | 8% |
| CCS | 4% | 17% |
| Total (Gt $CO_2$) | 3.1 | 15.0 |

Notes: Activity describes changes in the demand for energy services, such as lighting or transport services, due to price responses. Power plant efficiency includes emissions savings from coal-to-gas switching. For more detail on the decomposition technique used, see Box 9.4 in Chapter 9.

# Lighting: a CO2 Savings Opportunity

- Lighting is a large end-use of electricity (16-19%)
- Policy measures and economics are starting to move markets toward more efficient sources, including LED
- However, there are concerns with the market transition…
  - Quality issues associated with some LED products
  - Lack of globally harmonised test methods
  - Risk of repeating the mistakes of CFLs (i.e., market spoiling)
  - And overall, the pace is not fast enough
- This is why governments are increasing their efforts, including creating the SSL Annex

# IEA 4E SSL Annex

- **IEA** – International Energy Agency, the energy co-operation forum of OECD countries, based in Paris
- IEA **4E** – Efficient Electrical End-Use Equipment – so called Implementing Agreement: Multilateral research and deployment activities
- IEA 4E **SSL** sponsoring countries:
  - Australia, Denmark, France, Japan, the Netherlands, Republic of Korea, Sweden, United Kingdom, United States and China (China has expert status, not a full member)
- Other countries are welcome

# Goals of the SSL Annex (2010-2014)

To provide funding governments with:

- Tools to assess the performance of SSL,
- Information assisting formation of energy-efficient lighting policies, and
- Provision for harmonised test procedures and laboratory accreditation

To ***increase confidence in SSL in the marketplace.***

# SSL Annex: Three Main Tasks

- Task 1: Develop SSL product quality assurance
  - Create performance tiers, address equivalency claims
  - Collect data on Life Cycle Assessment, Health issues
- Task 2: Harmonised SSL testing and lab comparison
  - Provide for harmonised national and regional testing protocols (CIE, IEC, ANSI, etc.)
  - Interlaboratory Comparison – Part 1: exercise to calibrate the four Nucleus laboratories – NIST, NLTC, NMIJ/AIST and VSL
  - Interlaboratory Comparison – Part 2: international IC testing to calibrate participating laboratories ("2013 IC")
- Task 3: Provide for harmonised International Accreditation
  - Propose proficiency testing procedure for accreditation
  - Inform AB's about the 2013 IC
  - Support participants in applications for accreditation

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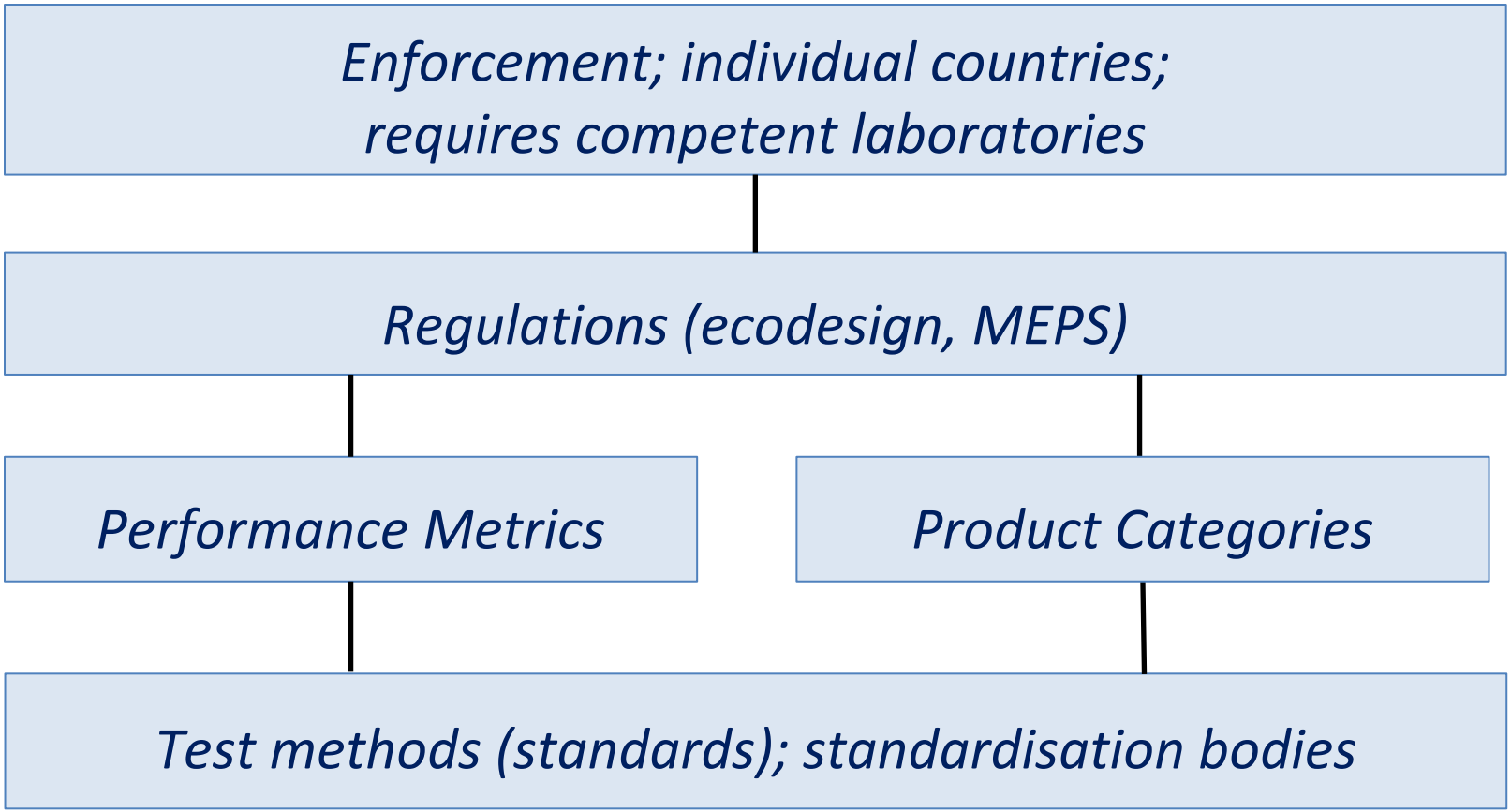
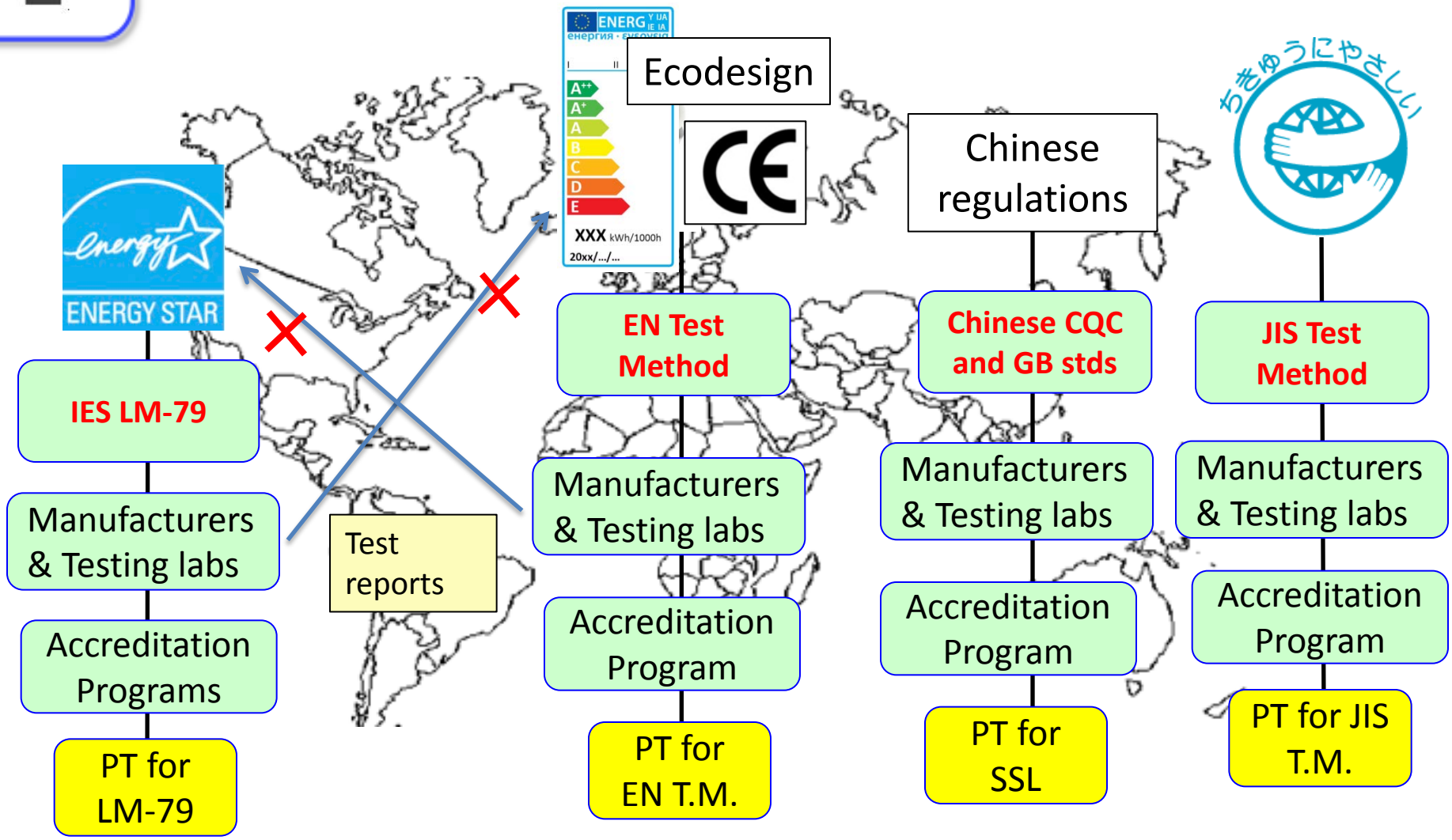
# Task 2: Harmonised testing and lab quality comparison

- Need for international Harmonization in SSL Testing and Accreditation
- Task 2 looks at testing methods and laboratory comparison

# From Test Methods to Enforcement

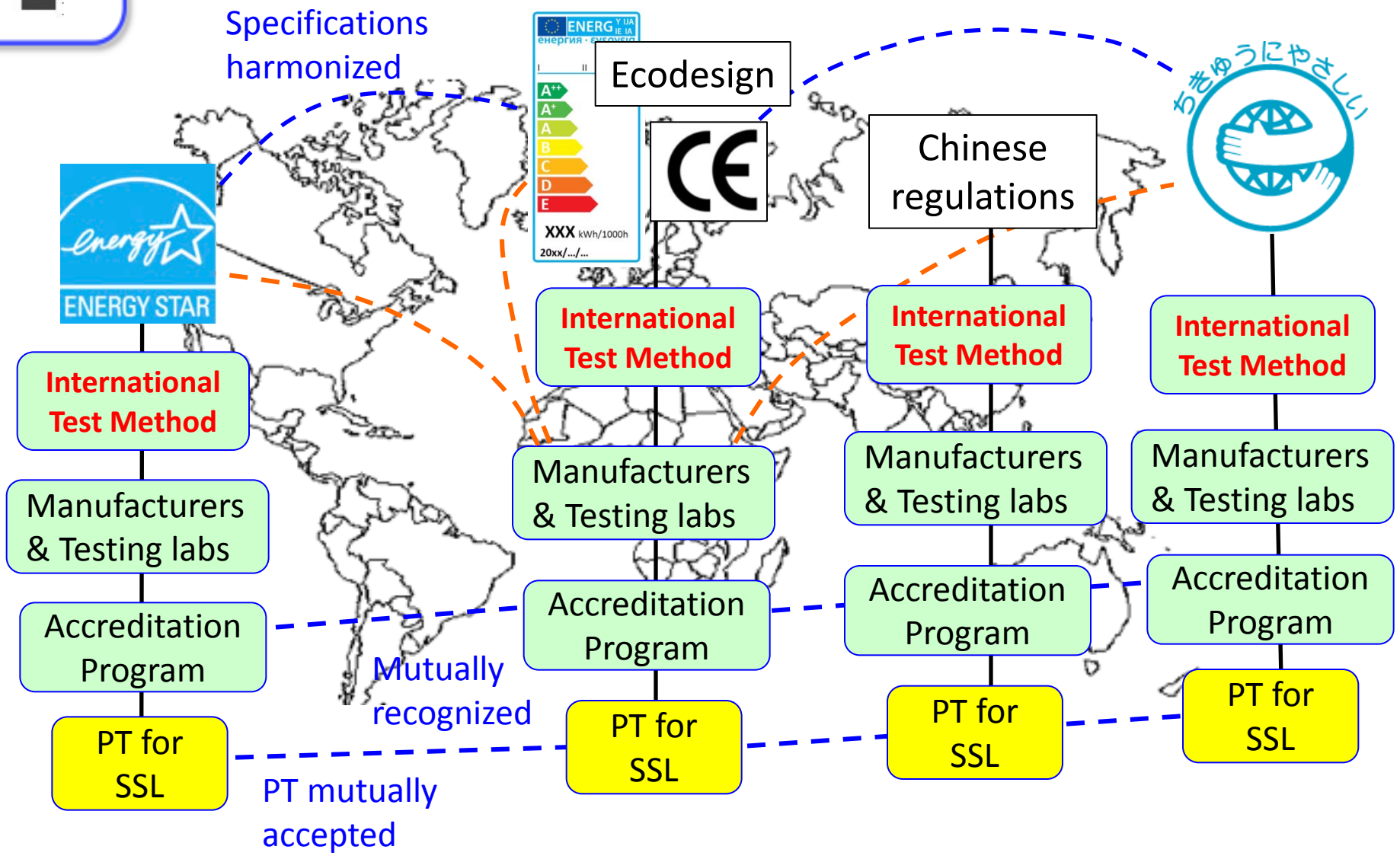


# The Need for International Harmonization

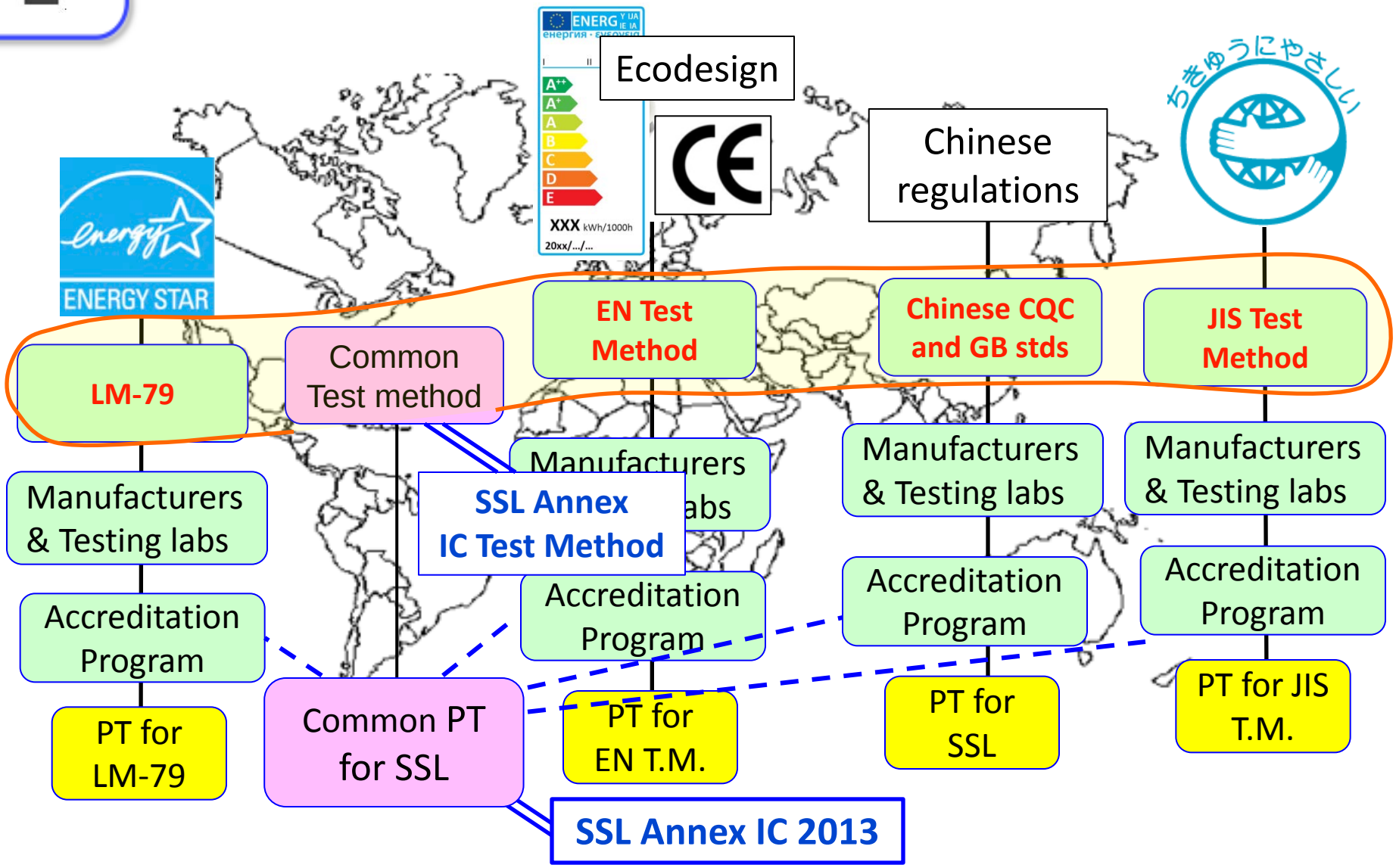



Different Test methods, different APs, different PTs

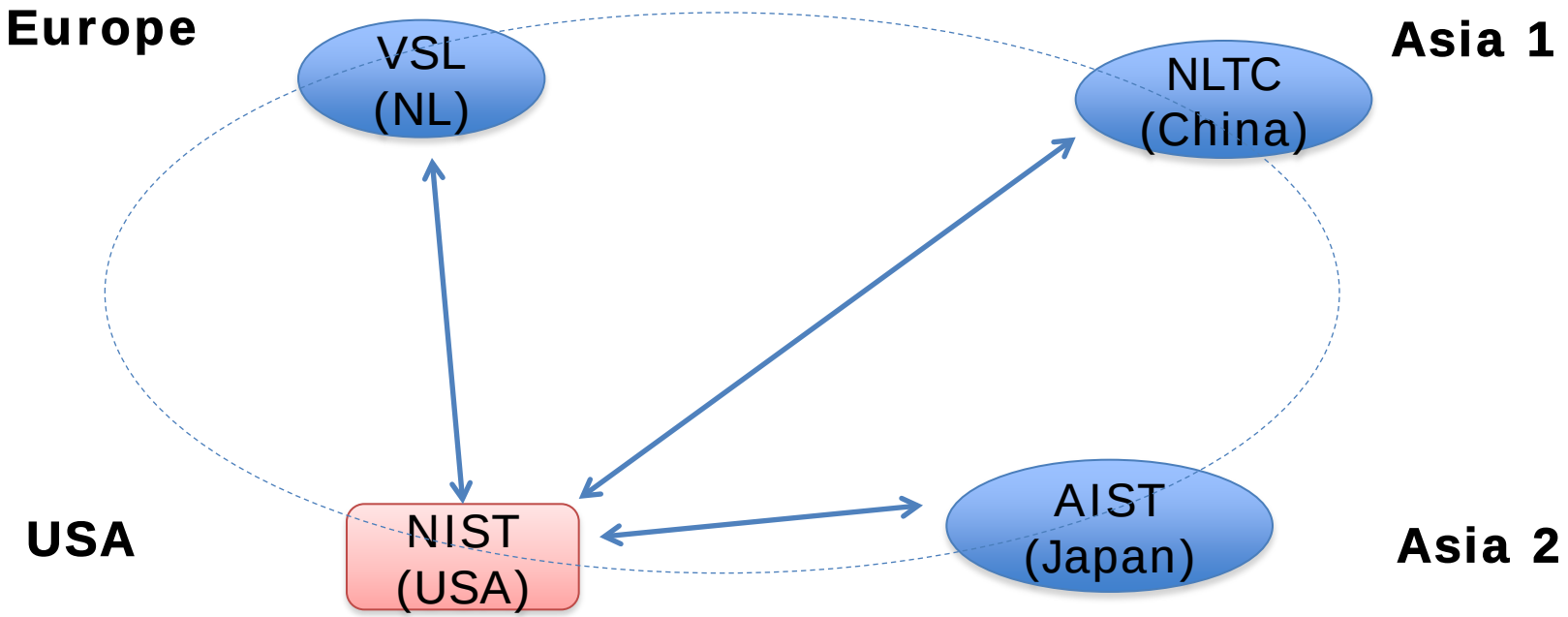
# Ideal Scheme – Global Harmonisation



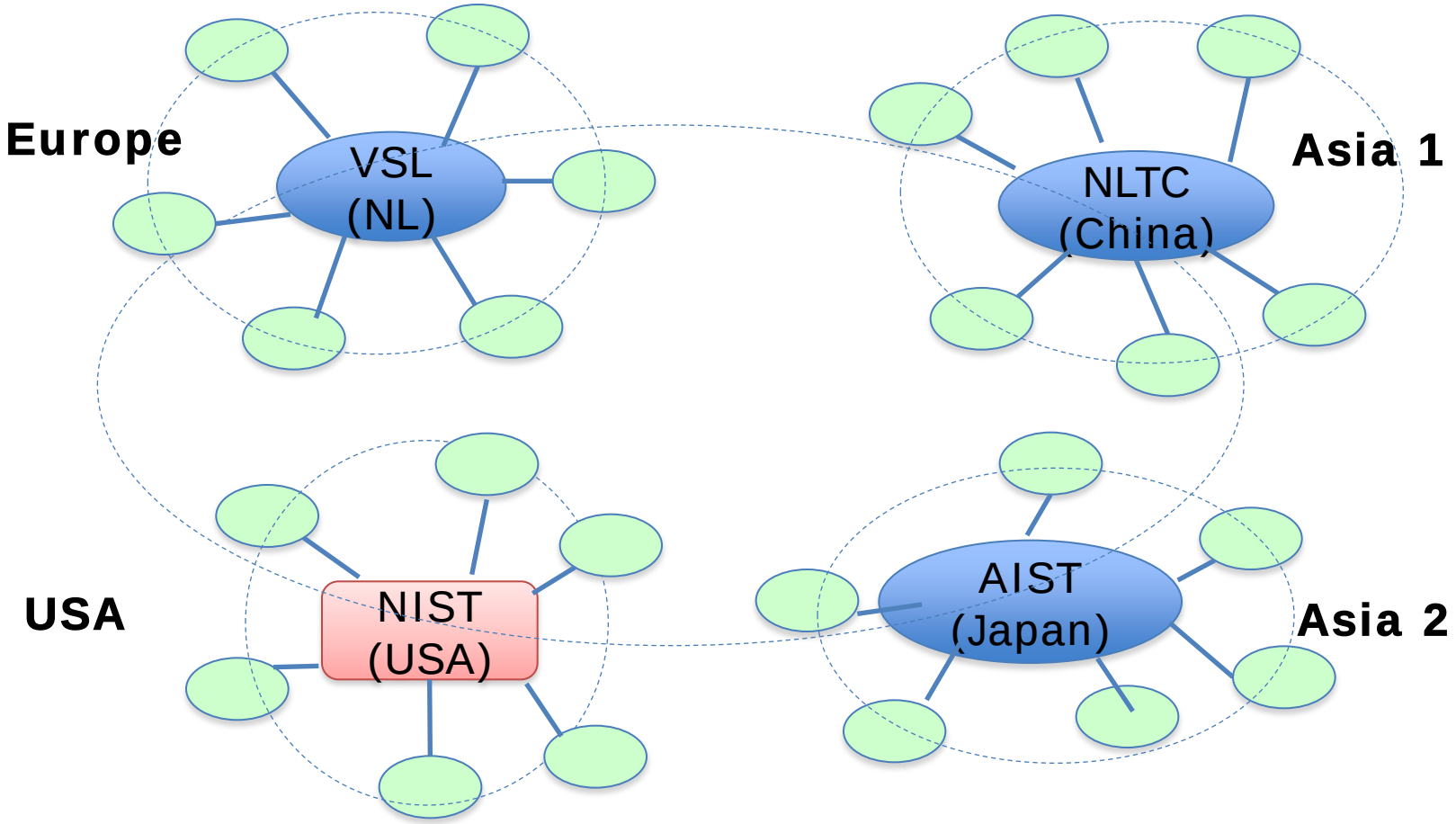
# Short-Term Solution
# Common PT (SSL Annex IC 2013) using IC Test Method



# Task 2: Nucleus Laboratories: Interlaboratory Comparison Testing

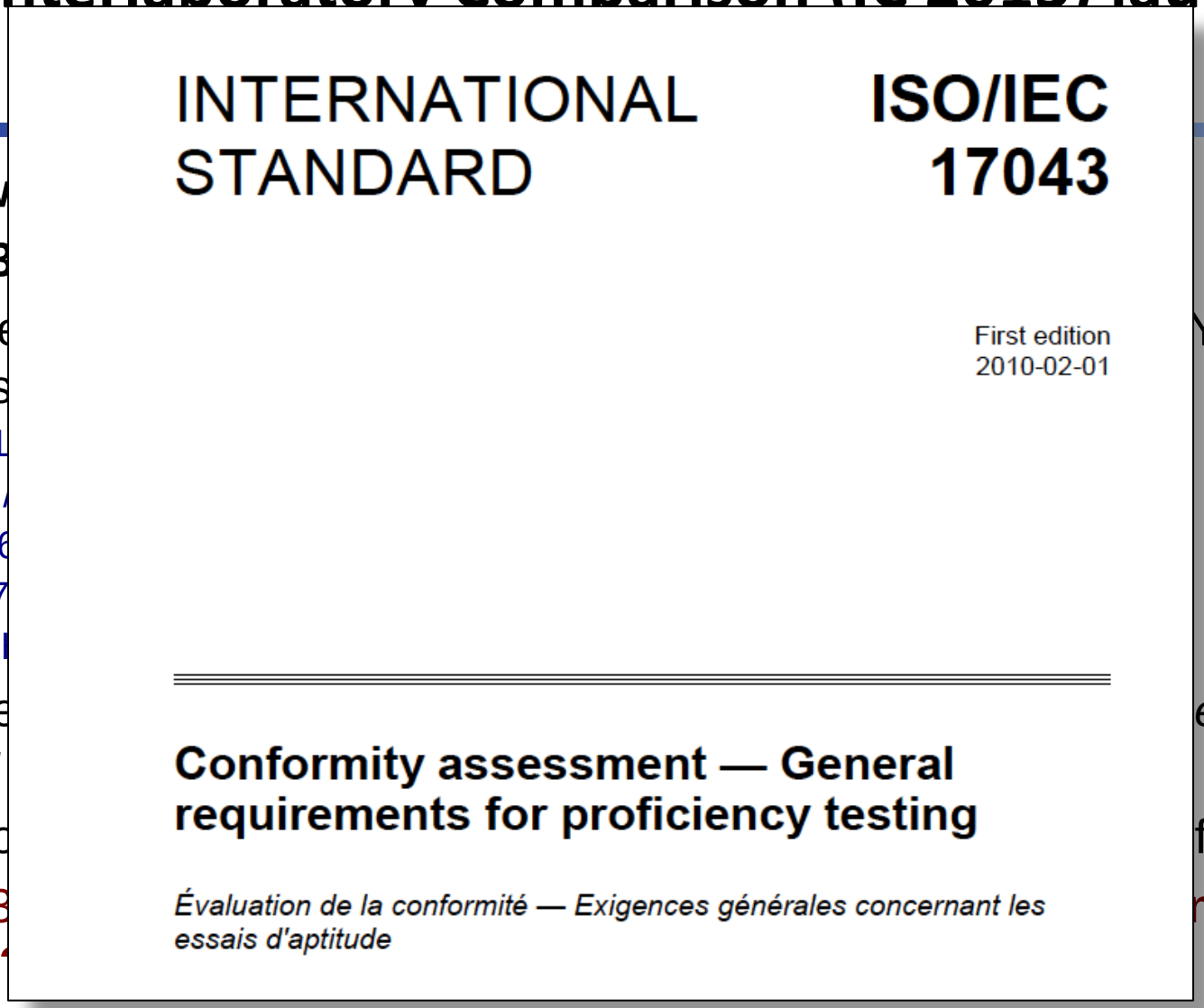


# Task 2: SSL Annex 2013 Interlaboratory Comparison Testing



# Interlaboratory Comparison (IC 2013) launched

- **Joint w**
- **IC 2013**
- Designe Y of the SSL tes
  - IES L
  - CEN
  - IEC 6
  - JIS 7
  - FGB
- Prepare *ent – General*
- Open to fee)
- IC 2013 **n, CNAS(**
- **APLAC PT program (CNAS/NLTC) is linked to IC2013.**



INTERNATIONAL STANDARD

**ISO/IEC 17043**

First edition
2010-02-01

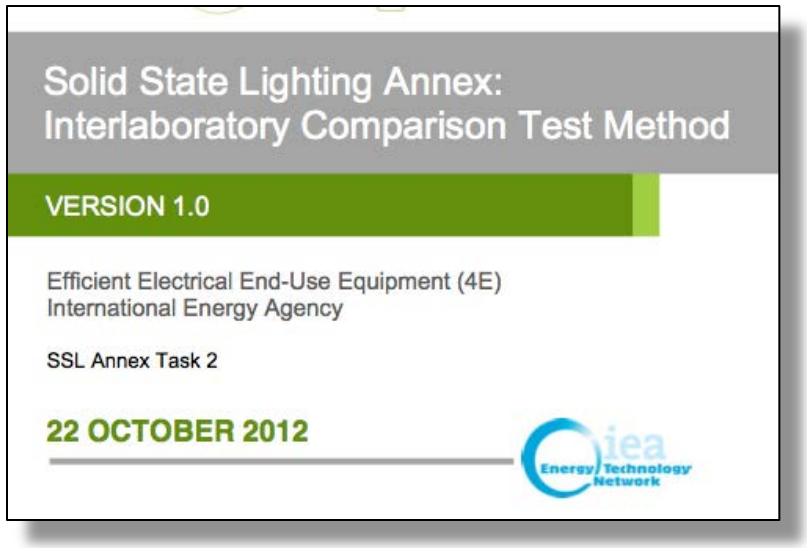
**Conformity assessment — General requirements for proficiency testing**

*Évaluation de la conformité — Exigences générales concernant les essais d'aptitude*

# Documents Developed for 2013IC

- Announcement Letter about the IEA 4E SSL Annex 2013*
- Application form*
- Report of Nucleus Laboratory Comparison (Miller, Scholand)*
- IC Test Method version 1.0 (Ohno)*
- Test Method Comparison Table (Ohno)*
- IC Generic Protocol (Ohno, Miller, Nara)*
- IC Regional Protocols (NIST, VSL, NMIJ, NLTC)
- Quality Policy document (Nara)
- Letter to Accreditation Bodies (Nara)
- Letter to NVLAP PT, NIST MAP participants (Ohno, Miller)

# SSL Annex IC Test Method

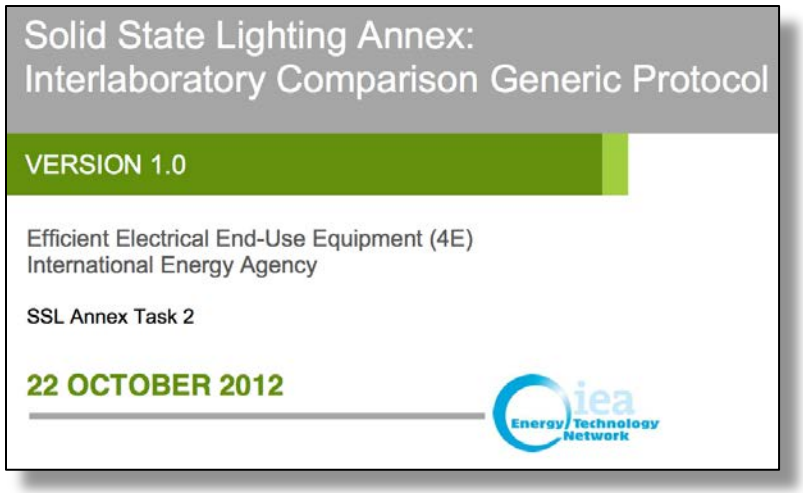



Available at

http://ssl.iea-4e.org/files/otherfiles/0000/0051/SSL_Annex_2013_IC_Test_Method_v.1.0.pdf

- This test method was developed specifically **to support IC 2013**, due to the absence of a published international standard.
- Encompasses requirements in
  - IES LM-79
  - CEN/CIE test method (draft)
  - IEC 62722 (LED luminaire), IEC 62612 (LED lamp) Annex
  - Chinese CQC and GB standards related to SSL testing
  - JIS 7801, 8105-5 related to SSL testing
- Select the **most stringent** requirements of above.
- Select requirements **relevant to SSL Annex IC.**
- Covers measurement of **electrical, photometric and colorimetric** characteristics of **LED lamps and LED luminaires**. (Life and reliability testing is not covered)
- **Test Method Comparison Table** is in Annex..

# SSL Annex IC 2013 Generic Protocol




available at
http://ssl.iea-4e.org/files/otherfiles/0000/0053/SSL_Annex_IC_Generic_Protocol.pdf

**Prepared to be compliant with ISO/IEC 17043**

**3. Description of the Comparison Artefacts**
- Type of products (required, optional)
- Electrical operating condition
- Operating orientation

**4. Properties measured for Comparison**
- Total luminous flux (lm)
- Electrical power(W), voltage, current
- Luminous efficacy of source (lm/W)
- Chromaticity (x, y), CCT, CRI

**5. Reference Values and Assigned Values**

**6. Testing Period and Shipping Instructions**

**8. Measurement Procedure**

SSL Annex IC Test Method

**11. Evaluation of the Performance**

**12. Reporting to the Participants**

**14. Eligibility of Participation and Fee**

# IC 2013 Protocol: Artefacts

- The following five different types of lighting products are selected by each each Nucleus Lab considering the needs in the region

    1) Incandescent lamp (AC operation)
    2) Omnidirectional LED lamp
    3) Directional LED lamp
    4) High CCT LED lamp or luminaire (>5000 K)
    5) Low power factor LED lamp (PF <0.6)

- In addition, IC testing in each region can include one or more of the following optional artefacts considering the needs in the region

    1) Incandescent lamp – DC operation
    2) Tubular type LED lamp 3
    3) Remote-phosphor type LED lamp
    4) Street lighting LED luminaire

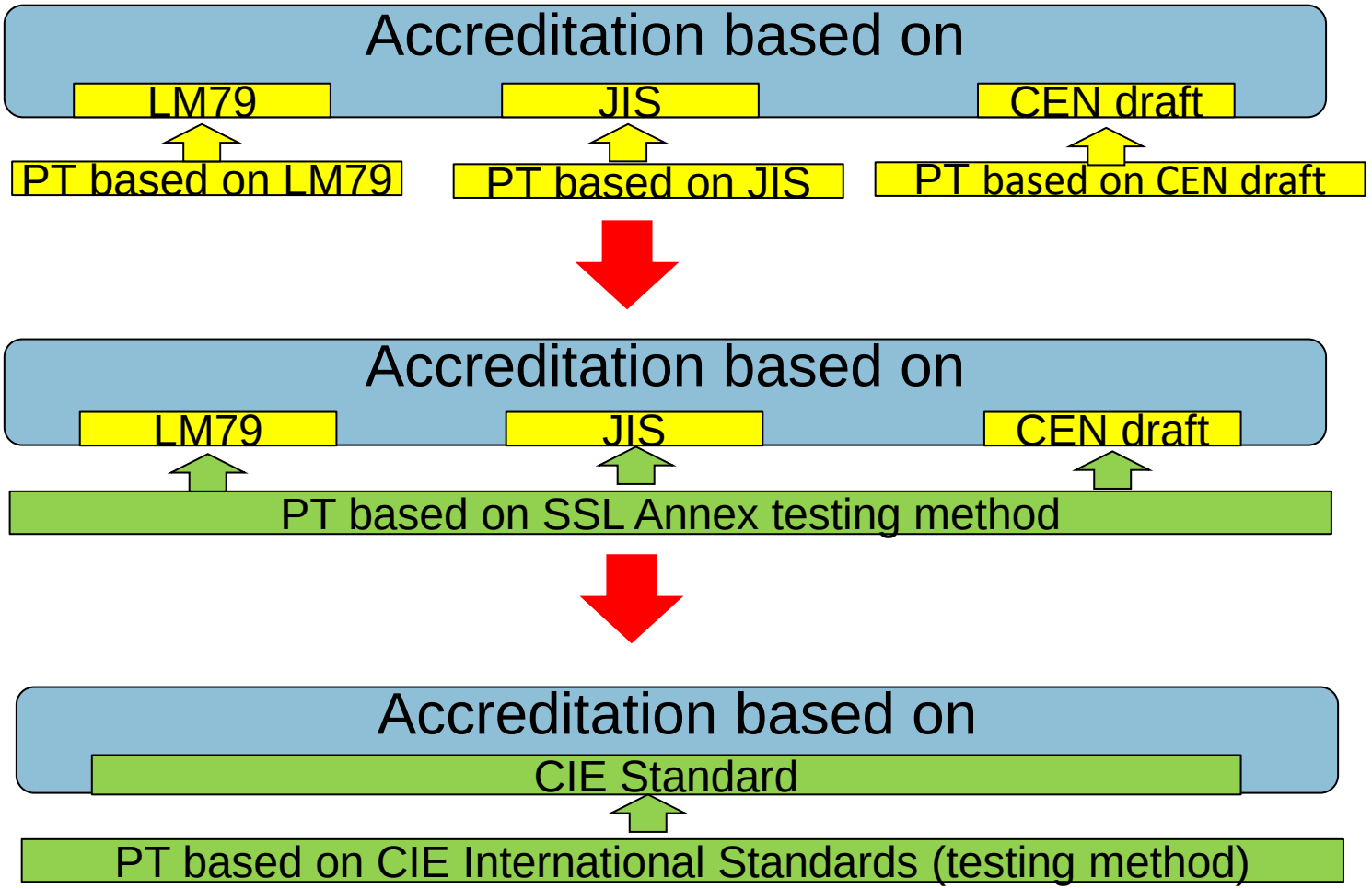
Details are specified in **Regional Protocols**, available from Nucleus labs.

# Support for Proficiency Testing

Past

IC2013

**Future**



# Outcomes of IC2013

***If one stop SSL proficiency testing program is established,***

- ABs do not have to organize PTs for each measurement method.
  - AB may use of 2013 IC result as the evidence of the competence to carry out the assessment for different measurement methods.
- The participating laboratories will not have to participate in additional PTs.
- By using a method for IC2013, PT for SSL will be simplified. It will benefit ABs, laboratories and scheme (mark) owners.

**IC2013 is now to be recognized by NVLAP and IAJapan**

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# IC 2013 IC 2013 Protocol: Analysis

## 9 Uncertainty Calculation by the Participants

Uncertainty statements are basically required by the IEA 4E SSL Annex Interlaboratory Comparison Test Method because it is required by the current draft of the CEN/CIE test method. Other test methods do not require uncertainty statements. If a participant seeks accreditation for the forthcoming CEN/CIE test method, then uncertainty shall be reported along with the results. Otherwise, uncertainty evaluation and reporting is not required although it is always recommended. If measurement uncertainty is reported, the total uncertainty of each measured quantity shall be expressed in expanded uncertainty with a confidence interval of 95 % or a coverage factor $k$=2.

# IC 2013 IC 2013 Protocol: Analysis

## 11 Evaluation of the Performance

The assigned values are given by the Nucleus Laboratory. The criteria used to analyse and evaluate the performance are given by the $E_n$ number (defined in ISO 13528 and ISO/IEC 17043) and $z'$ score (defined in ISO 13528). The $E_n$ numbers can be calculated if the uncertainty values are reported by a participating laboratory. The $z'$ score is calculated for all results, and is determined by:

$$z' = \frac{x - X}{\sqrt{\hat{\sigma}^2 + u_X^2 + u_{\text{drift}}^2}}$$

where $\hat{\sigma}$ is the SDPA value (Standard Deviation for Proficiency Assessment; in this IC test, the generic standard uncertainty of a participant's measurement) and $u_x$ is the standard uncertainty of the reference value (average of uncertainties measurement of the LED lamps by four Nucleus laboratories reported in the Nucleus Laboratory Comparison Report [see Ref. 2]), and $u_{\text{drift}}$ is the uncertainty contribution from the expected artefact drifts (controlled to within 0.8 x SDPA, see section 7) calculated by:

# En Number

e) $E_n$ numbers are calculated using Equation (B.5):

$$E_n = \frac{x - X}{\sqrt{U_{\text{lab}}{}^2 + U_{\text{ref}}{}^2}}$$

where

$U_{\text{lab}}$ is the expanded uncertainty of a participant's result;

$U_{\text{ref}}$ is the expanded uncertainty of the reference laboratory's assigned value.

(ISO/IEC 17043)

- assures that participant's uncertainty values are appropriate.
- Does not assure the level of uncertainty of participant.

| | Current [%] | Active power [%] | Luminous flux [%] | Luminous efficacy [%] | Chroma-ticity x | Chroma-ticity y | CCT [K] (3000K) | CCT [K] (6000K) | CRI Ra |
|---|---|---|---|---|---|---|---|---|---|
| $\hat{\sigma}$ | 0.35 | 0.45 | 1.2 | 1.3 | 0.0010 | 0.0011 | 15 | 43 | 0.3 |
| $u_x$ | 0.28 | 0.41 | 0.61 | 0.78 | 0.0010 | 0.0008 | 14 | 41 | 0.3 |
| $\sqrt{\hat{\sigma}^2 + u_X^2 + u_{\text{drift}}^2}$ | **0.45** | **0.62** | **1.37** | **1.53** | **0.0014** | **0.0014** | **21** | **60** | **0.4** |

| Deviation in | Luminous flux [%] | Luminous efficacy [%] | Chromaticity $x, y$ |
|---|---|---|---|
| z'=3 | 4.1 % | 4.6 % | 0.0042 |

If a value of $|E_n| > 1.0$ is calculated, this is generally considered to be unsatisfactory. The value of $2.0 < |z'| < 3.0$ is considered to be questionable, and $|z'| \geq 3.0$ is generally considered to be unsatisfactory, but the judgment as to whether the result is acceptable will depend on the potential ABs. The $E_n$ numbers (if available) and the z' scores of all participants will be reported in the interim and final reports in the event that they might be used by ABs.

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# IC 2013: Participants

- 56 Laboratories + several NIST NVLAP and MAP cross-registering + any NLTC/CNAS/APLAC linked

- Countries registered directly:
  - Australia
  - Belgium
  - Brazil
  - Canada
  - China & Taiwan
  - Denmark
  - Finland
  - France
  - Germany
  - India
  - Japan
  - Korea
  - Netherlands
  - New Zealand
  - Russia
  - Sweden
  - United Kingdom
  - USA

# IC 2013: Time Scale and Reports

- **Announced in Oct. 2012**. (accept applications and start measurements)
- Applications accepted by end of March 2013.
- Run **measurements by June 2013**.
- **Formal Results Notification (FRN)** to participant after measurement of each lab is complete.
- **Interim reports** (for each region) to be available by Sep. 2013.
- **Final report** (all data) to be available in 2014.

(In these reports, participants' results will be expressed using **random lab codes**, and only the participant will be informed.)

# Thank you, any questions?

- http://ssl.iea-4e.org/

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