# 5. Bottom up – method 9: Improvement of lighting systems (tertiary sector)

# 5.0 Recalling Elements of Calculation:

## Four steps for calculation

- **step 1**: **unitary gross annual energy savings**
  **(per end-use action)**
  (**+**) no. of participants or units
- **step 2**: **total gross annual energy savings**
  **(of a facilitating measure)**
  (**+**) double counting, multiplier effect, free rider effect
- **step 3**: **total ESD annual energy savings**
  **(of packages of EEI measures)**
  (**+**) timing and lifeline of end-use action within ESD period and performance degradation
- **step 4**: **total ESD energy savings for year "i"** **(i=2010 or 2016)**

# 5.0 Recalling Elements of Calculation: Three levels of evaluation efforts

| | Data scale | Main data sources | Data processing and documenting |
|---|---|---|---|
| Level **1** | **European default values** | **existing/available** European regulation, studies and statistics | **security factor** according to the level of **reliability** of the default value |
| Level **2** | **National** representative **values** | **up-to-date** national statistics, surveys, samples, registries | requirements = **minimum set of information and justifications** to be reported |
| Level **3** | **Program- or Participant-specific** | **specific** monitoring systems, registries, surveys, measurements | requirements to report on the specific data and justifications **in detail** (standard report at least available) |

➔ an evaluation method may combine different levels of efforts, as several parameters are needed in the calculations

## 5.1 Harmonised bottom-up evaluation methods
## Method 9: Improvement of Lighting Systems

- a method dealing with several types of **end-use actions** and their **combination**
- the **unit** is a Lighting System installed at a **Participant**
- In combination of end-use actions to improve lighting systems in the tertiary sector, large energy savings can be made (up to 80 %)

(method developed by eERG – Politecnico di Milano, Italy)

## 5.1 Improvement of Lighting Systems - end-use actions

- Exchange of **lamps:** Incandescent => Compact Fluorescent Lamps (CFLs); T12 => T8 => T5 Fluorescent Lamps
- Use of **electronic ballasts** instead of electromagnetic ballasts
- Use of energy-efficient **luminaires**
- Improved **lighting controls**

# 5.1 Improvement of Lighting System

- **Step 1.1: Basic calculation formula for the <u>unitary</u> savings**

  *quite complex formula to calculate the following:*

  *Annual energy savings of one participant = the participant's energy consumption with an inefficient lighting system – the participant's energy consumption with an energy-efficient lighting system*

# 5.1 Improvement of Lighting System

- **Step 1.2: Baseline (reference system)**

→ The baseline against which to calculate the energy savings depends on end-use action and situation

| End-use action | Advanced reinvest-ment or upgrade of existing system | Normal reinvestment or new build |
|---|---|---|
| Use of energy-efficient lamps, ballasts, luminaires | Energy efficiency of existing system / stock average | Energy efficiency of new, inefficient system / market inefficient average |
| Improved lighting controls | Energy efficiency of existing system / stock average | Energy efficiency of new, efficient system / market efficient average |

# 5.1 Improvement of Lighting System

- **Step 1.3: Normalisation factors**

→ Annual Operating hours are both an input parameter for the calculation of energy savings, and a potential normalization factor for energy use of lighting systems.

→ Proposed Level 1 Normalisation Factors:

1.2 for Northern Europe (DK, FI, SE, EST, LV, LT; NO)

1.1 for Western Europe (UK, IRL)

1.0 for Central Europe (AT, BE, CZ, DE, FR, HU, LU, NL, PL, SK)

0.9 for Southern Europe (BG, CY, ES, GR, IT, MA, PO, RO, SL)

# 5.1 Improvement of Lighting System

- **Step 1.4: Specifying the calculation method and its three related levels: two options depending on complexity of end-use actions**

A) [savings] are estimated **for CFLs, electronic ballasts, occupancy and daylight sensors** using a default value (in kWh/year/unit) or a default % of savings in **level 1** (EU default values for parameters) and **level 2** (national average values for parameters from sample surveys), or a **measure-specific level 3** (average values for parameters from surveys of a sample of participants to the facilitating measure being evaluated).

# 5.1 Improvement of Lighting System

- **Step 1.4: Specifying the calculation method and its three related levels**

B) [savings] are estimated **for more complex combinations of end-use actions,** particularly if **energy-efficient luminaires** with T8 or T5 lamps and electronic ballasts are used**, with a case-specific level 3 method of evaluation, using the complex formula but possibly some level 1 values.**

# 5.1 Improvement of Lighting System

- **Indicative default value** for the unitary savings **(1)**

→ default values for **option A, Level 1:**

| End-use action | Savings against stock average baseline | Savings against market inefficient average baseline |
|---|---|---|
| Use of CFLs instead of Incandescents | 102 kWh/year/CFL | 102 kWh/year/CFL |
| Use of electronic ballasts with T8 systems | 23 kWh/year/ballast | 17 kWh/year/ballast |
| Use of occupancy sensors on T8 systems | 76 kWh/year/sensor or 20 % | 76 kWh/year/sensor or 20 % |

# 5.1 Improvement of Lighting System

- **Indicative default value** for the unitary savings **(2)**

→ default values for **option B, Level 1:**

| End-use action | energy consumption of baseline system | energy consumption of energy-efficient system |
|---|---|---|
| Use of efficient luminaires with T8 systems | 90 kWh/year/ballast | 76 kWh/year/ballast |
| Use of efficient luminaires with T5 systems | 90 kWh/year/ballast | 79 kWh/year/ballast |
| Annual hours of use | 2,500 h/year | 2,500 h/year |
| Number of luminaires | **Case-specific! (Level 3)** | **Case-specific! (Level 3)** |

# 5.1 Improvement of Lighting System

- **Step 2.1: calculation formula for the <u>total gross</u> annual energy savings**

  - unit = one lighting system (Participant).

$$Total\_gross\_annual\_energy\_savings = \sum_{i}^{n} [energy\_savings\_of\_Participant\_i]$$

# 5.1 Improvement of Lighting System

- **Step 2.2: Requirements and methods for accounting for the number of unitary actions**

→ Methods proposed for monitoring the number of actions (always LEVEL 3):

| | |
|---|---|
| **Direct accounting methods are particularly appropriate with the use of:**<br>- Financial Tools (rebates, low interest rates, targeted taxation, e.g., tax rebates or faster depreciation rates)<br>- Energy Audits<br>- Energy Performance Contracting<br>- White Certificates Schemes | **Examples of methods**<br>- Collection of accounting documents (e.g. invoices, vouchers)<br>- registry/database to collect details about participants and end-use actions proposed/taken |
| **Indirect accounting methods are particularly appropriate with**<br>- Minimum Energy Performance Standards<br>- Lifecycle costing campaigns | **Examples of methods**<br>- surveys among the target groups to assess the portion/number of implemented end-use actions<br>- surveys among the whole population targeted to assess compliance |

→ Finally, ex-post verification for a sample of participants should be done: monitoring of implementation and of energy consumption to ensure that end-use (EEI) actions are actually in place and operational, as specified initially.

# 5.1 Improvement of Lighting System

- **Step 3.1: formula for the <u>total ESD</u> savings**

*total net annual energy savings*
*= total gross annual energy savings of all participants (from step 2.1)*
** (1 - free-rider coefficient + multiplier coefficient)*
** double-counting factor*

→ Simplified formula, if total annual energy savings are below 40 million kWh/year, or if there is evidence that both the multiplier and the free-rider effects will be small:

*total net annual energy savings*
*= total gross annual energy savings of all participants (from step 2.1)*
** double-counting factor*

Possible range of coefficients:
Free-rider: share [0, 1]
Multiplier coefficient: >=0
Double Counting: factor [0, 1]

# 5.1 Improvement of Lighting System

- **Step 3.2: double counting**

| | Energy Audits | Energy Performance Contracting | White Certificates Schemes | Energy Taxation | Subsidy schemes | Risk of Overlap |
|---|---|---|---|---|---|---|
| Energy-efficient Luminaires | X | X | X | X | X | X |
| Energy-efficient Lamps& ballasts | X | X | X | X | X | X |
| Improved Control | X | | | | X | X |
| …. | | | | | | |

- **Step 3.3: technical interactions**
  - **Interaction possible with HVAC systems: reduced cooling/increased heating demand**

# 5.1 Improvement of Lighting System

## Step 3.4: multiplier effect

Indicators and data that can be used:

- sales data analysis (numbers and efficiency levels)
- Surveys among representative samples of (non-)participants
- Surveys with trade allies and/or other relevant stakeholders

## Step 3.5: free-rider effect

| | |
|---|---|
| 1st approach | Stock/Market modelling:<br>Level 2 - Baseline based on National Statistics<br>Level 3 – Measure specific Data |
| 2nd approach | Definition of Net-to-Gross Ratios (NTGR) (implies surveys to participants or discrete choice modelling)<br>Level 2 - National NTGR<br>Level 3 – Measure Specific NTGR |
| 3rd approach | Progressive Approach |

# 5.1 Improvement of Lighting System

- **Step 3.5: free-rider effect - proposed Level 1 default values for free-rider coefficient based on market data**

| End-use action | Proposed free-rider coefficient for EEI measures in the years 2008 and 2009 |
|---|---|
| Use of CFLs | 0.5 |
| Electronic ballasts | 2008: 0.6<br>2009: 0.65 |
| Efficient luminaires - T8 | 0.5 |
| Efficient luminaires - T5 | 0.3 |
| Occupancy sensors | 0.05 |

# 5.1 Improvement of Lighting System

- **Step 4: savings lifetime - default values from CWA-27**

| | |
|---|---|
| **New/renovated office lighting *(Commercial/ Public sector)*** | **12 years** |
| **Motion detection light controls *(Commercial /Public sector)*** | **10 years** |

- **Early Action:**

- If decided to be eligible, early energy savings could be counted from 2004/2006 using these default values

- The same Level 1 default values presented above for unitary annual energy savings could be used

# 5.1 Improvement of Lighting System

- **Quality assurance / uncertainties**

Still to be developed!