PRIORITY ACTION FIVE

LIGHTING SYSTEMS

WHAT ARE LIGHTING SYSTEMS?

Lighting systems use both artificial light sources like lamps, luminaires and light fixtures, as well as natural illumination by capturing daylight, using windows, skylights or light shelves to achieve practical or aesthetic effects. Proper lighting can enhance task performance, improve the appearance of an area and increase security.

WHAT ARE THE BENEFITS OF THE ENERGY SAVINGS ACHIEVED?

Energy savings achieved via lighting systems provide a reduction in the associated costs of electricity and in carbon dioxide emissions. The replacement of old technologies with LED (light-emitting diode) light sources extends the lifetime of savings and reduces maintenance costs.

WHAT ARE THE ENERGY SAVINGS OPPORTUNITIES?

One major opportunity is the replacement of installed technologies with more energy efficient light sources, such as LEDs, and with lighting control systems. The streamSAVE project developed a methodology to adequately account for the savings achieved through the implementation of such energy efficiency measures.

WHAT MAKES CALCULATING ENERGY SAVINGS CHALLENGING?

Lighting systems differ from one another and existing calculation methodologies are not harmonised across Member States. Calculating savings through the use of lighting controls, behavioural aspects, data scarcity and the consideration of standards for a proper baseline definition are also main challenges.

WHAT IS NEEDED TO IMPROVE ENERGY SAVINGS CALCULATIONS?

There is a need to define a methodology including indicative values in order to establish a harmonised baseline to calculate energy savings. This methodology should be based on quality standards and account for the use of new and more efficient technologies and lighting control systems.

The streamSAVE project received funding from the Horizon 2020 Programme under grant agreement Nº 890147.

Welcome and Agenda

Please rename yourself in zoom: Name (organisation, country code)

Agenda

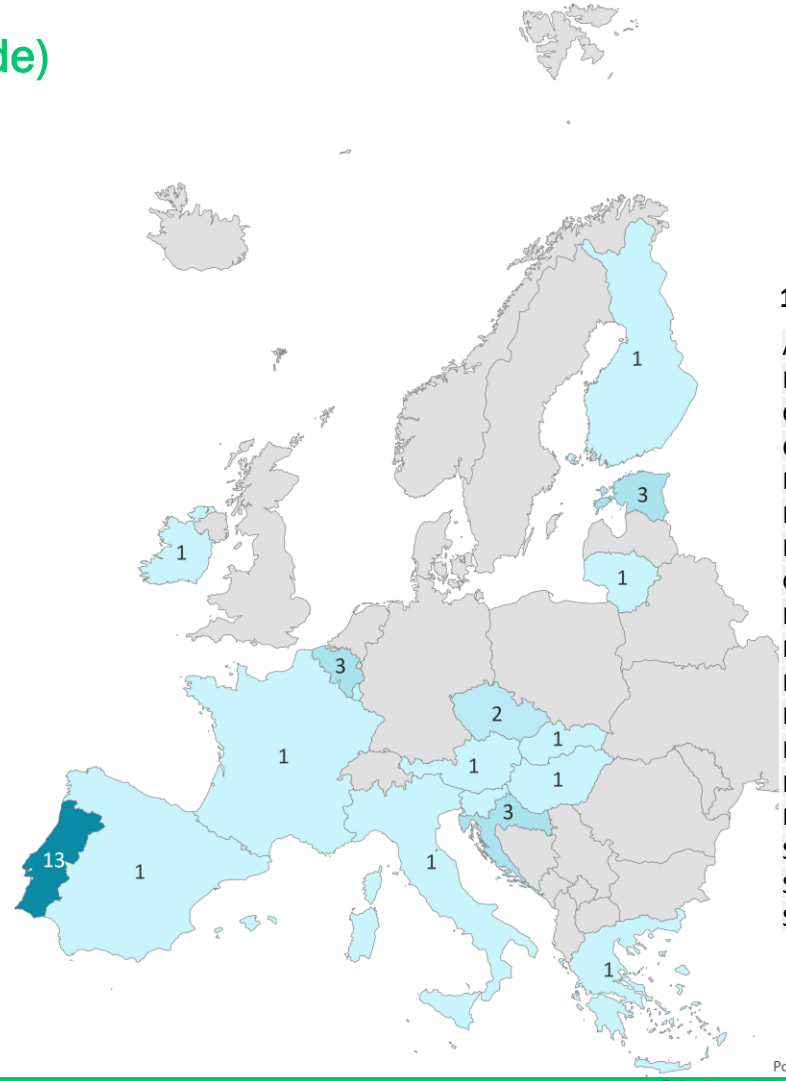
15:00 – 15:05 Welcome to participants

15:05 – 15:25 Overview of the energy savings calculation methodology developed for “road lighting systems”,
by Carlos Patrão (ISR-University of Coimbra)

15:25 – 15:55 Questions and Answers (Q&A) with open debate with participants:
- Feedback about the presented methodology;
- Key issues for the calculation methodology: discussion about sources of information for baseline definition, indicative values, costs and country specific data.

moderated by Carlos Patrão (UC) and Elisabeth Böck (AEA)

15:55 – 16:00 Conclusions and next steps



18 different countries

Austria	1
Belgium	3
Croatia	3
Czech Republic	2
Estonia	3
Finland	1
France	1
Greece	1
Hungary	1
Ireland	1
Italy	1
Lithuania	1
Luxembourg	1
Malta	2
Portugal	13
Slovakia	1
Slovenia	1
Spain	1

Lighting systems including public lighting

Status of methodology for "Road Lighting Systems"

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2nd PA Dialogue Group, 1 June 2021

This project has received funding from the Horizon 2020 programme under grant agreement n°890147. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

stream SAVE

INSTITUTE OF SYSTEMS AND ROBOTICS
UNIVERSITY OF COIMBRA

Presentation outline

- Scope of the methodology
- Calculation of final energy savings (Article 7)
- Data sources for the indicative values
- Calculation of impact on energy consumption (Article 3)
- Calculation of greenhouse gas savings
- Challenges
- Open debate / Q&A

Scope of the methodology

- The savings calculation methodology targets:
  - road lighting systems;
  - replacement of existing technologies for more energy efficient;
  - including lighting controls.

- «Road Lighting» instead of «Street/Public/Outdoor Lighting»
  - “Road Lighting” is more aligned with the most recent EU GPP (stakeholders' suggestion), EN 13201 and CIE115.

Calculation of final energy savings (Article 7)

Calculation of final energy savings (Article 7)

- First formula follows a *"Project-based approach"*:

$$TFES = \left[\left(N_{ref} \times \sum_{i=0}^{n} \frac{(P_{ref} \times t_{ref\,i} \times D_{ref\,i})}{1000}\right) - \left(N_{eff} \times \sum_{i=0}^{n} \frac{(P_{eff} \times t_{eff\,i} \times D_{eff\,i})}{1000}\right)\right] \times f_{BEH}$$

- Second formula a more *"Simplified approach"*:

$$TFES = \left[\sum_{j=1}^{n} (N_j \times ES_j \times LC_j)\right] \times f_{BEH}$$

Calculation of final energy savings (Article 7)

"Project-based approach":

$$TFES = \left[\left(N_{ref} \times \sum_{i=0}^{n} \frac{(P_{ref} \times t_{ref\,i} \times D_{ref\,i})}{1000}\right) - \left(N_{eff} \times \sum_{i=0}^{n} \frac{(P_{eff} \times t_{eff\,i} \times D_{eff\,i})}{1000}\right)\right] \times f_{BEH}$$

Baseline system data

New system data

effects

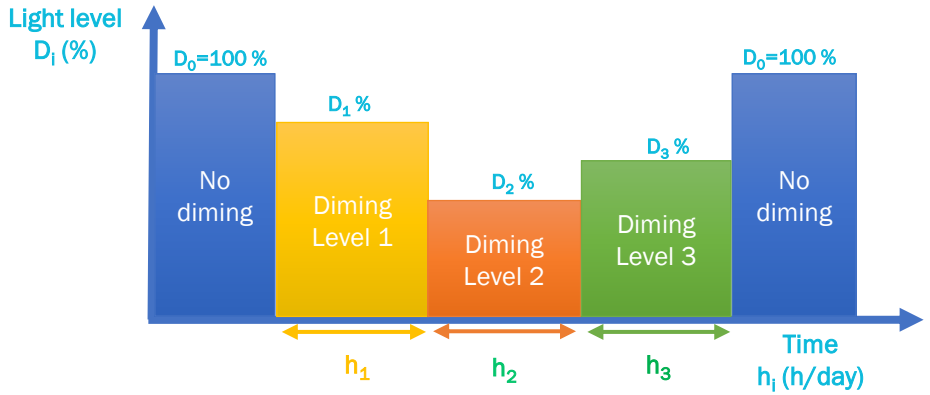
TFES	Total final energy savings [kWh/a]
N_{ref}	Number of light points in the old/inefficient system
N_{eff}	Number of light points in the new/efficient system
P_{ref}	Power of each light point of the old/inefficient system, including lamp and other components on the luminaire (e.g.: control gear and communication/control units) (W)
P_{eff}	Power of each light point of the new/efficient system, including lamp and other components on the luminaire (e.g.: control gear and communication/control units) (W)
$t_{ref\ i}$	Annual operating time (h/a) of light points of the old/inefficient system in diming level "i" ($D_{ref\ i}$)
$D_{ref\ i}$	Percentage of working light points power, of the old/inefficient system, during the diming level "i"
$t_{eff\ i}$	Annual operating time (h/a) of light points of the new/efficient system in diming level "i" ($D_{ref\ i}$)
$D_{eff\ i}$	Percentage of working light points power, of the new/efficient system, during the diming level "i"
f_{BEH}	Factor for correction of behavioural effects (rebound, spill-over effect and free-rider effect)
i	Diming levels "i", being "0" the lighting full power mode
n	Total number of diming levels

Calculation of final energy savings (Article 7)

- *"Project-based approach"*:

$$TFES = \left[\left(N_{ref} \times \sum_{i=0}^{n} \frac{(P_{ref} \times t_{ref\,i} \times D_{ref\,i})}{1000}\right) - \left(N_{eff} \times \sum_{i=0}^{n} \frac{(P_{eff} \times t_{eff\,i} \times D_{eff\,i})}{1000}\right)\right] \times f_{BEH}$$

- *Diming/Lighting controls strategies*:
  - Defined by each MS for old and new technology.



Calculation of final energy savings (Article 7)

"Project-based approach" – Indicative values

Total annual operating time	[h/a]
Total annual operating hours of lighting system (sum of time with and without diming, that must be equal to $\sum_{i=0}^{n} t_{ref\ i}$ and $\sum_{i=0}^{n} t_{eff\ i}$)	4015
Factor for correction of behavioural effects	**[no dimension]**
Factor for correction of behavioural effects (f_{BEH})	1
Lifetime of savings	**[years]**
Lifetime of savings	10 years

Power of the light source (P_{ls}) W	Minimum control gear efficiency ($\eta_{control\ gear}$) %
$P_{ls} \leq 30$	78
$30 < P_{ls} \leq 75$	85
$75 < P_{ls} \leq 105$	87
$105 < P_{ls} \leq 405$	90
$P_{ls} > 405$	92

Indicative values for the control gear efficacy according to Ecodesign

$$P_{ref} = \left(\frac{P_{ls}}{\eta_{control\ gear}}\right)$$

Calculation of final energy savings (Article 7)

"Simplified approach":

$$TFES = \left[\sum_{j=1}^{n} N_j \times ES_j \times LC_j\right] \times f_{BEH}$$

Pre-calculated savings — effects

TFES	Total final energy savings (kWh/a)
N_j	Number of light points in the lighting system "j"
ES_j	Indicative value for the Energy Savings of each light point in the lighting system "j", according to the table below (kWh/a)
LC_j	Factor to account for the savings according to the lighting control strategy used in the lighting system "j", according to the table below. In the absence of light control technologies, this factor is "1".
f_{BEH}	Factor for correction of behavioural effects (rebound, spill-over effect and free-rider effect)
j	Lighting system "j"
n	Total number of lighting systems

Indicative values

Old/inefficient light point		New/efficient light point		Energy savings (ES_j) [kWh/a]	Value for the ratio (LC_j)	
Technology	Lamp power (W)	Technology	Light point power (W)		Diming to 50% for 7 h/day	Diming to 50% for 5 h/day
High-Pressure Sodium (HPS)	400	Light Emitting Diode (LED) with at least 120lm/W	250	777.76	1.41	1.29
	250		160	471.12	1.43	1.31
	200		125	388.88	1.41	1.29
	150		95	286.68	1.42	1.30
	100		60	219.76	1.35	1.25
	70		40	169.40	1.30	1.22
	50		30	115.28	1.33	1.24
Metal-Halide (MH)	400	Light Emitting Diode (LED) with at least 120lm/W	300	577.76	1.66	1.47
	250		180	391.12	1.59	1.42
	175		125	277.76	1.57	1.41
	150		110	226.68	1.62	1.44
	70		50	129.40	1.49	1.35
Factor for correction of behavioural effects				**[no dimension]**		
Factor for correction of behavioural effects (f_{BEH})				1		
Lifetime of savings				**[years]**		
Lifetime of savings				10 years		

Data sources for the indicative values

- Total annual operating hours
  - EuP Lot 9, EuP Lot 37, EU GPP
- Lifetime of savings
  - Impact assessment of (EC) No 2019/2020, Model for European Light Sources Analysis (MELISA), 40.000h
- Efficiency of the high intensity discharge (HID) lamps
  - (EC) No 245/2009 and (EC) No 2019/2020
- Efficiency of LED light sources
  - (EC) No 2019/2020
- Diming levels
  - EU GPP, TS3 for minimum dimming performance: pre-set level of dimming down to at least 50 %
  - 7 hours is used in Austrian methodology
- Other: calculations

Calculation of impact on energy consumption (Article 3)

Calculation of impact on energy consumption (Article 3)

- Formula:

$$\text{APES} = TFES \times PEF_{Electricity}$$

APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh/a]
$PEF_{Electricity}$	Primary Energy Factor for electricity

- Indicative values for the PEF are prepared for EU level, but national values can be used.

Primary Energy Factor ($PEF_{Electricity}$)	[-]
Electricity (EU value)	2.281

Calculation of greenhouse gas savings

Calculation of greenhouse gas savings

- Formula:

$$GHGSAV = TFES \times f_{GHG,electricity} \times 10^{-6}$$

GHGSAV	Greenhouse gas savings [t CO_2e p.a.]
TFES	Total final energy savings (kWh/a)
$f_{GHG,electricity}$	Emission factor for electricity [g CO_2e/kWh]

- Indicative values for the “emission factor for electricity” are prepared for EU level, but national values can be used.

$f_{GHG,electricity}$	[g CO_2e/kWh]
Electricity (EU value)	133.3

Challenges

- Data collection:
  - it is suggested that MS maintain a database with the installed and replaced technologies, for future track record and improvement assessment.
- Definition of baseline:
  - two different formulas with indicative values that will harmonize the baseline calculations among all MS.
- Approach to additionality:
  - EU regulations requirements are introduced into the specific final energy consumption of the reference to fulfil with the criterion of additionality.
- Prevention of double counting of savings:
  - The formulas calculate the savings provided by two different saving measurements: replacement of light sources and implementation of lighting control systems.

Challenges

Assessment of behavioural aspects:

- The methodology does not directly evaluate behaviour aspects, but the formula includes the option to consider behaviour aspects, such as rebound, spill-over and free-rider;
- For now, there's no sufficient data available for proposing indicative values at EU level.

Consider Ecodesign standards:

- The indicative values follow the requirements of the latest Ecodesign standards.

Calculation of energy savings through lighting controls:

- The formulas offer the possibility to calculate the energy savings provided by the implementation of lighting control systems.

Q&A / Open debate

Methodology for “Road Lighting Systems”

2nd Dialogue Group meeting

1 June 2021

Q&A and Open debate

- First pool of Q&A
  => Feedback on methodology
    - Results and open debate

- Second pool of Q&A
  => Data sources for baseline and indicative values
    - Results and open debate

If there is further information or formulas, or …, you are always welcome to share via chat, e-mail or Forum on streamSAVE platform.

Conclusions

Methodology for “Road Lighting Systems”

2nd Dialogue Group meeting

1 June 2021

Next steps

Methodology for “Road Lighting Systems”

2nd Dialogue Group meeting

1 June 2021

Next steps

- Meeting minutes
  - please feel free to send us your suggestions
- All information will be included on the platform
  - in case you are not registered yet, we will show you how
- Next round: late autumn 2021
- Suggestions for topics or want to share policy practices?

Next Dialogues Group

- Dates for the next Dialogue Groups web meetings

18.05.2021	Changed date 29.06.2021	01.06.2021	15.06.2021	22.06.2021
				
BUILDING AUTOMATION & CONTROL SYSTEMS	REFRIGERATION SYSTEMS	LIGHTING SYSTEMS	ELECTRIC VEHICLES	HEAT RECOVERY

All web-meetings will be from **3.00 to 4.00 pm CEST**.

- Subscribe via: **REGISTRATION LINK**
  or send an email to: dialogues@streamsave.eu

Feedback

- Please, fill out our quick feedback survey

- You may also leave us a longer message
  - Via forum on the streamSAVE platform
  - Via the anonymous form (link in the chat)
  - Via dialogues@streamsave.eu
    - Please accept as sender

- To receive more info → register on the streamSAVE platform: https://streamsave.flexx.camp/signup-0818ml

Thank you!

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2nd PA Dialogue Group, 1 June 2021