



Energy performance of buildings in the Flemish Region

Lighting in the energy performance regulation

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Overview

❖ Introduction

❖ EPBD calculation method in the Flemish Region

❖ Lighting in the calculation method

- Boundary conditions + flowchart
- Calculation method
- Summary influence factors



Introduction: Energy Performance of Buildings Directive (4 January 2003)

❖ 17 articles

❖ Among others:

- Art.1: objective
- Art.3: Adoption of a methodology (+ annex= specifications)
- Art.4: Setting of energy performance requirements
- Art.5: New buildings
- Art.6: Existing buildings
- Art.7: Energy Performance certificate
- Art.8: Inspection of boilers
- Art.9: Inspection of Air-Conditioning systems
- Art.14: Committee

❖ Deadline: 1 January 2006





Introduction: most important requirements

Implementation of EPBD by Member States

Each member state has to adopt :

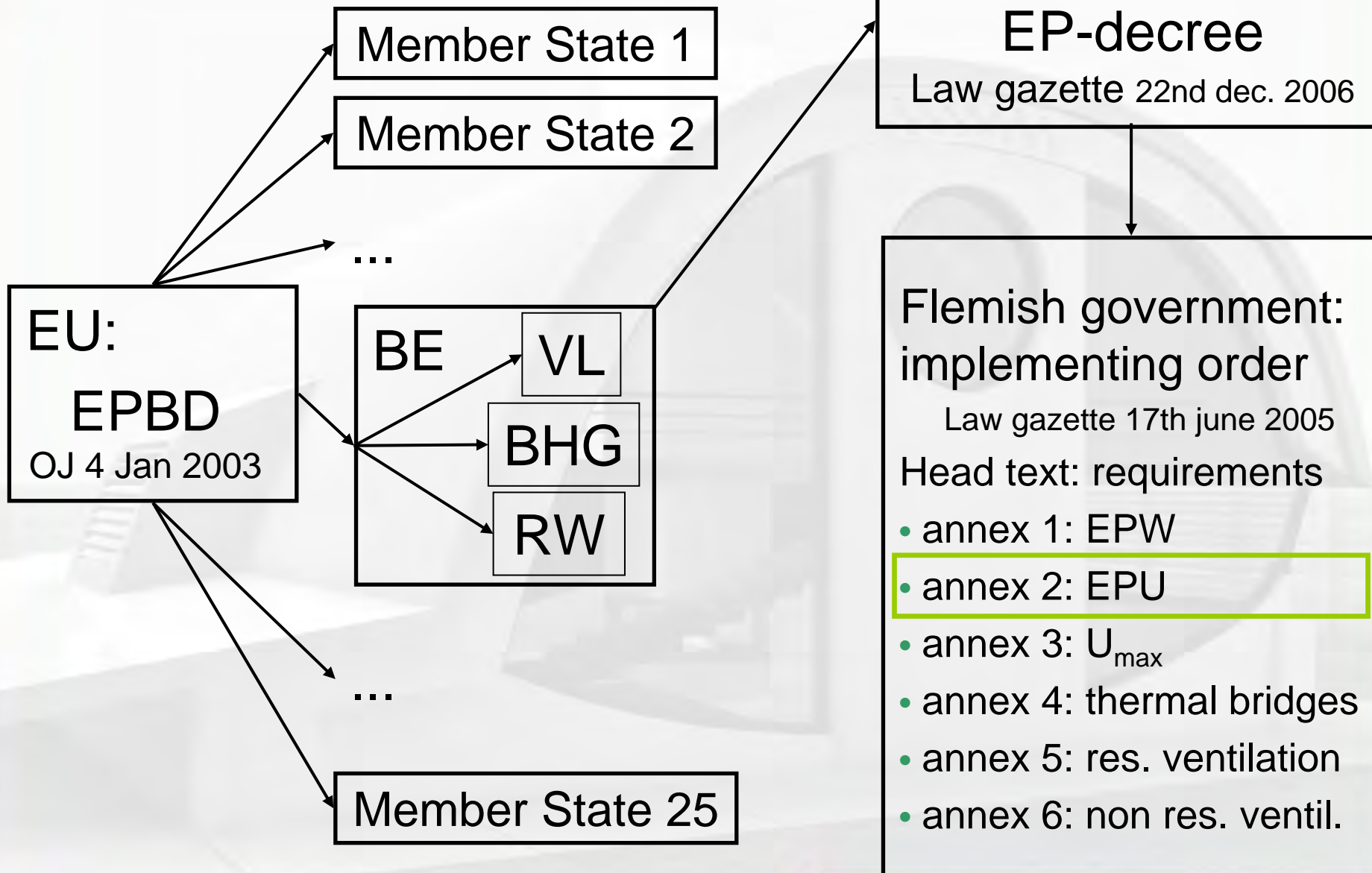
- ❖ Energy Performance calculation procedure(s)
- ❖ Requirements for all new buildings
- ❖ Requirements for (major) renovations
- ❖ Energy Performance certification of all buildings
- ❖ Mandatory inspection of boilers & AC systems

If lack of inspectors : January 2009

Deadline : January 2006

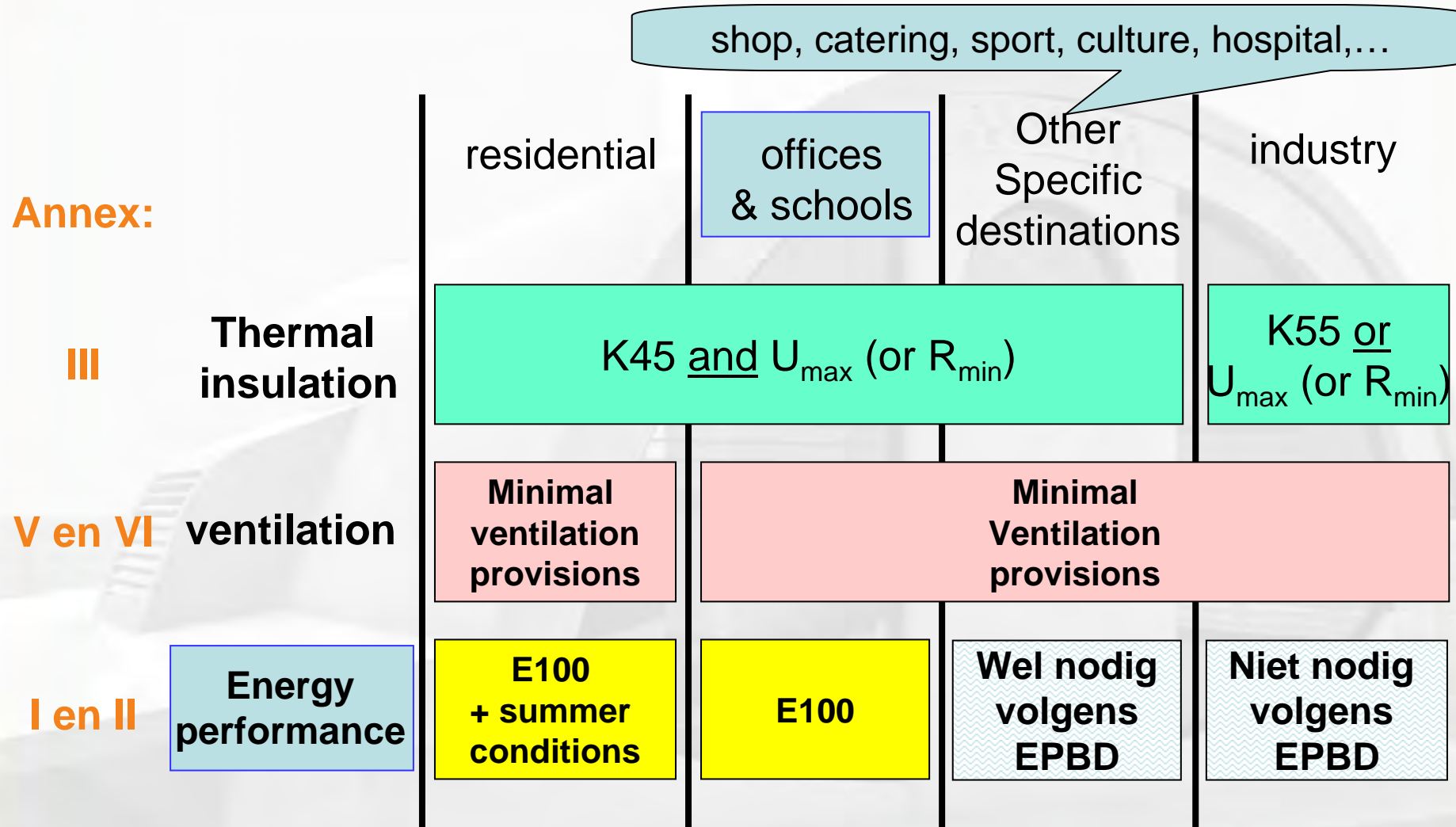


Introduction: state of affairs





EPBD legislation in the Flemish Region



EPBD : Energy Performance of Buildings Directive



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EPBD in Flemish Region: Basic philosophy

Characteristic annual primary
energy consumption

$$E = 100 \frac{\text{Characteristic annual primary energy consumption}}{\text{Reference value for the characteristic annual primary energy consumption}}$$

Reference value for the
characteristic annual primary
energy consumption

Function of:

- Building dimensions
- Ventilation demand
- (for EPU) lighting demand



EPBD in Flemish Region: Basic philosophy

$$E = 100 \frac{\text{Characteristic annual primary energy consumption}}{\text{Reference value for the characteristic annual primary energy consumption}}$$

EPW

Primary energy consumption for **space heating**
+
Primary energy consumption for **DHW**
+
Primary energy consumption for **fans and auxiliary energy**
+
Primary energy consumption for **cooling**
-
Possible primary energy gains through **PV or Cogen**

EPU

Primary energy consumption for **space heating**
+
Primary energy consumption for **lighting**
+
Primary energy consumption for **humidification**
+
Primary energy consumption for **fans and auxiliary energy**
+
Primary energy consumption for **cooling**
-
Possible primary energy gains through **PV or Cogen**

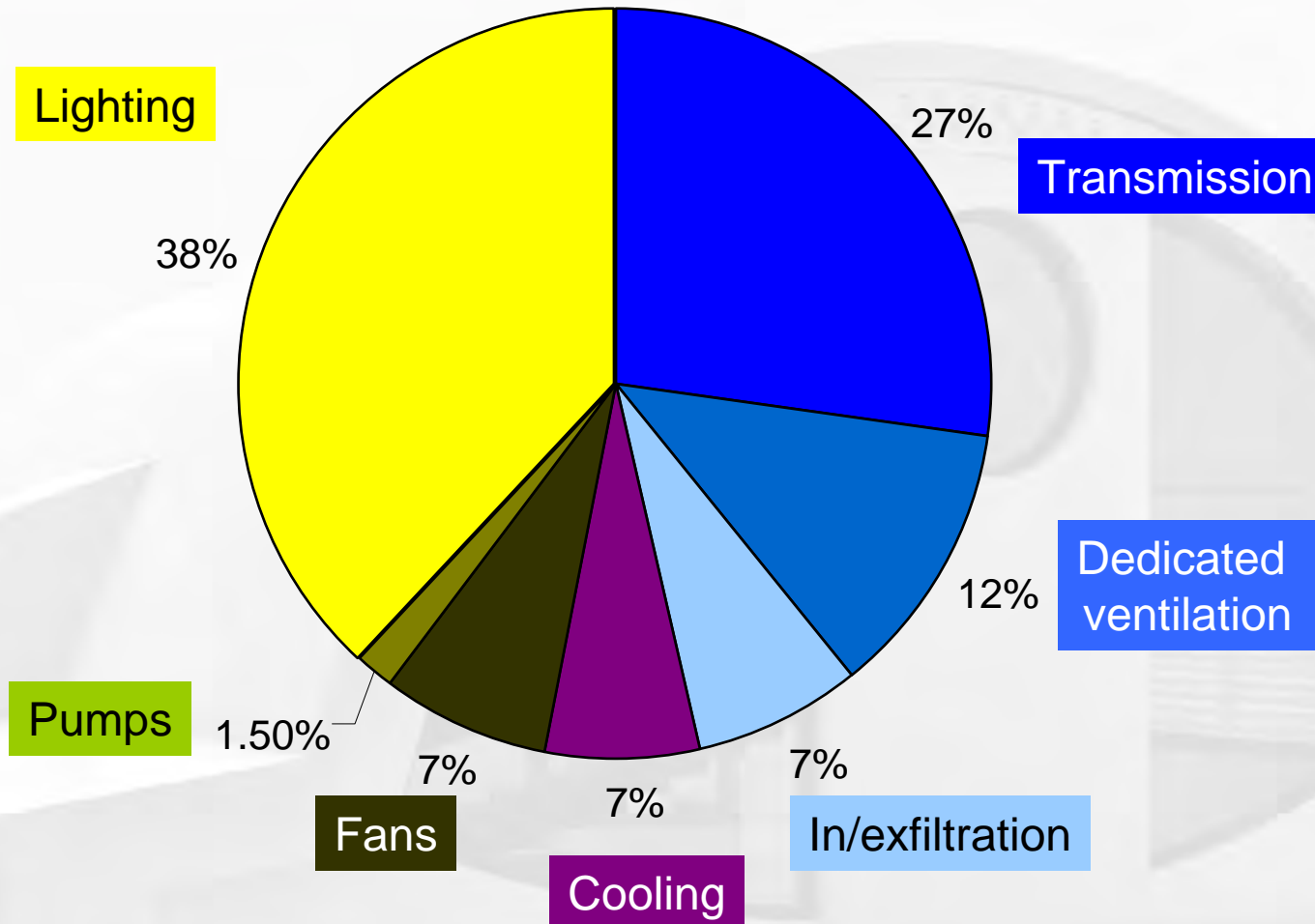


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Typical share of lightning in total energy consumption



→ Primary energy consumption for lighting is relatively important



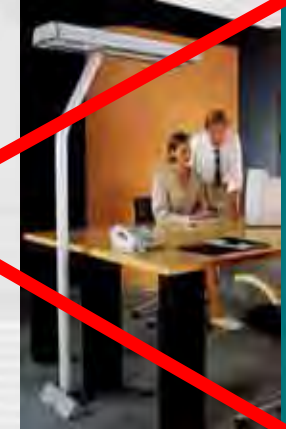
What types of lighting are considered in the calculation method?

❖ Not :

- Lighting outside the EPU-volume
- Outside lighting
- Portable lighting
- Security lighting

❖ Considered :

- All fixed luminaires





Lighting in the calculation method: numerator and denominator

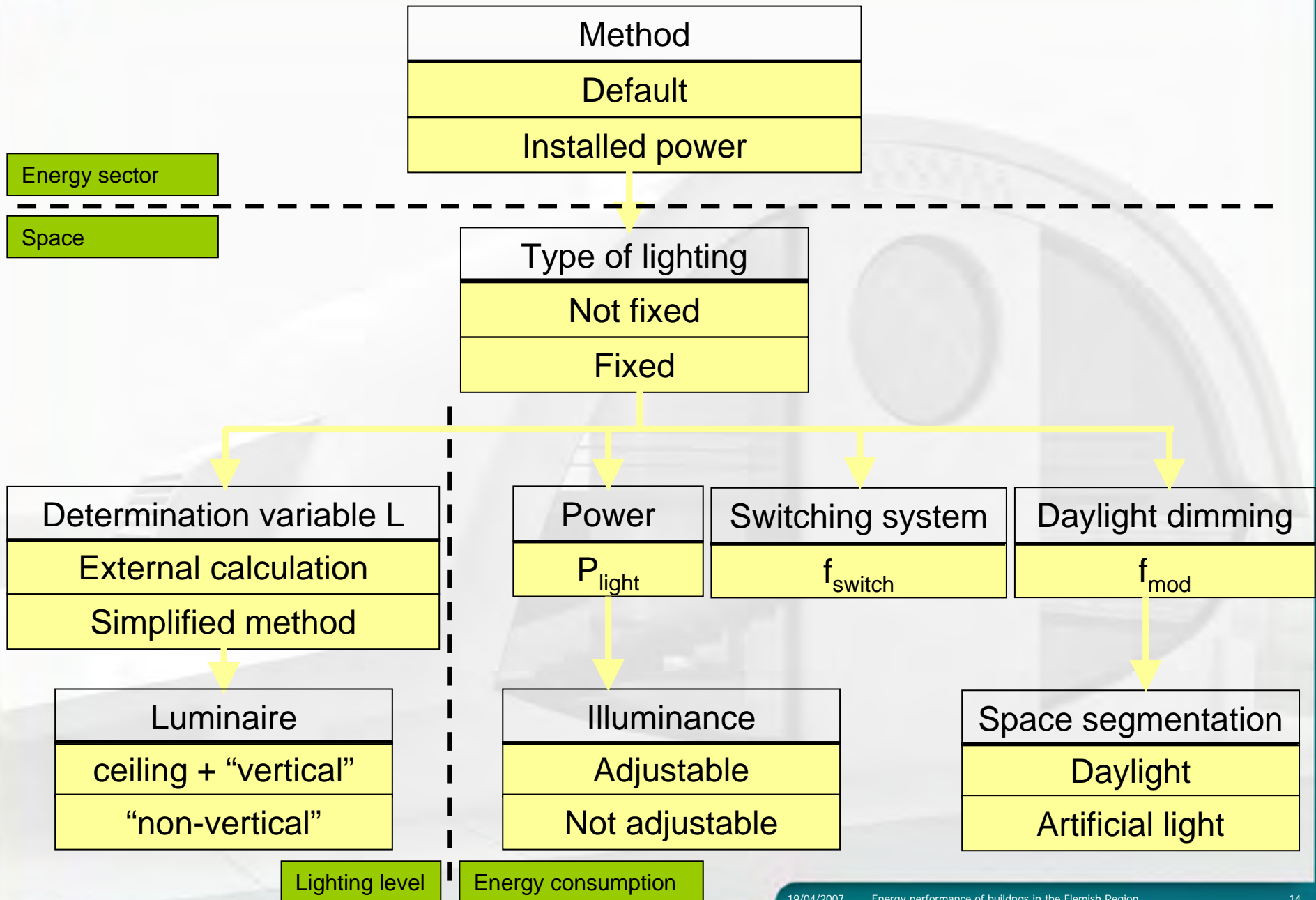
$$= \frac{\sum_{\text{without lighting}} E_{p,m} + E_{p,\text{light}}}{E_{\text{charannprimencons}}}$$

$$E_{\text{charannprimencons}} = b_1 \times A_f + b_2 \times A_{T,E} + b_3 \times \sum_r \dot{V}_{\text{supply, min, rm } r} + b_4 \times \sum_r (\dot{V}_{\text{supply, rm } r} - \dot{V}_{\text{supply, min, rm } r}) + b_5 \times 10^{-3} \times \sum_r [L_{\text{rm } r}^{0.8} \times (t_{\text{day}} + t_{\text{night}}) \times A_{f, \text{rm } r}]$$

$$E_{p,\text{light}} = f_p \times 3.6 \times W_{\text{light}}$$

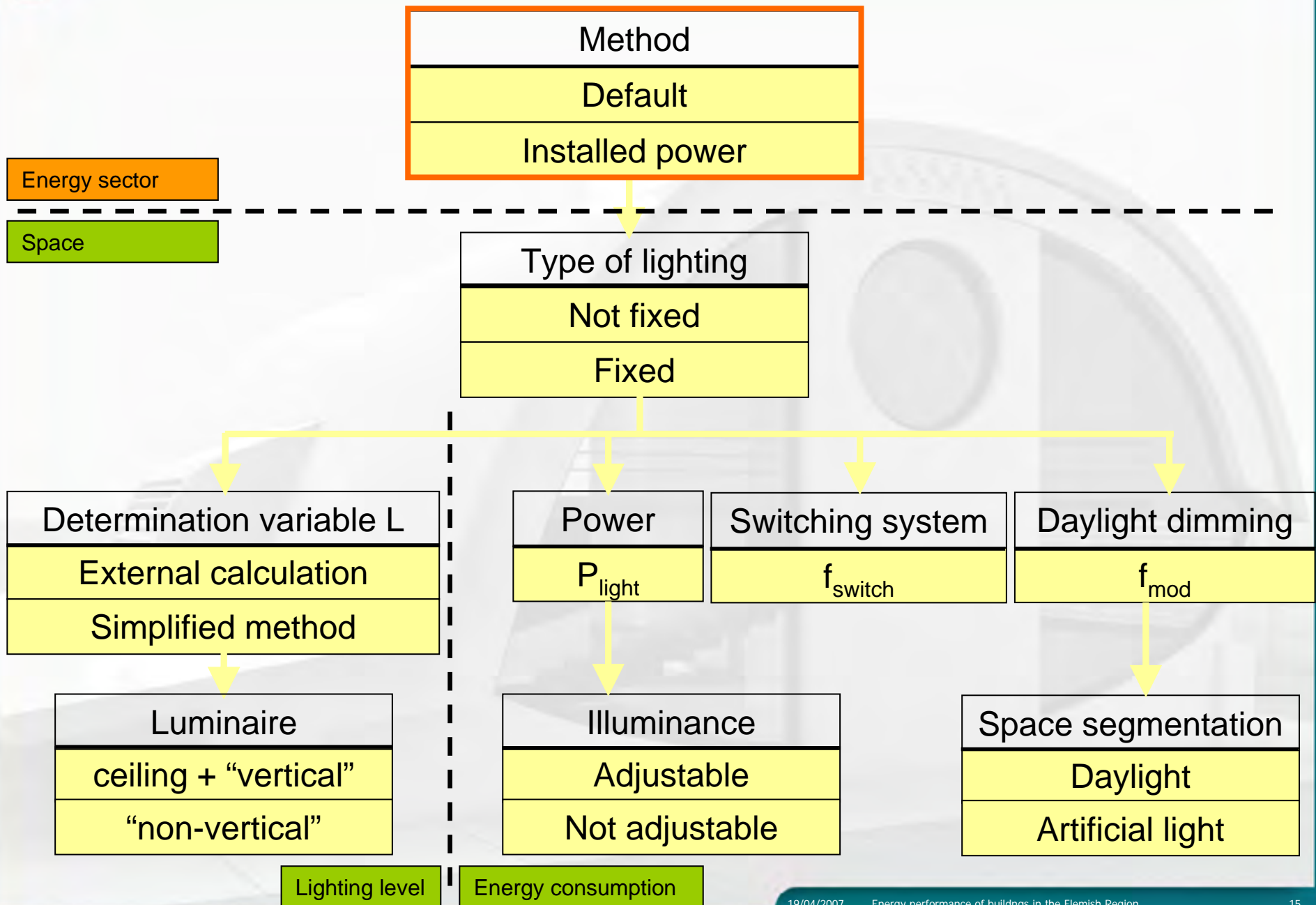


Lighting in the calculation method: flowchart





Lighting in the calculation method: flowchart





Lighting in the calculation method: method

❖ Calculation method (for each energy sector)

- Default

$$L_{\text{rm r}} = 500$$

$$W_{\text{light}} \text{ for } 20\text{W/m}^2$$

→ unfavourable value

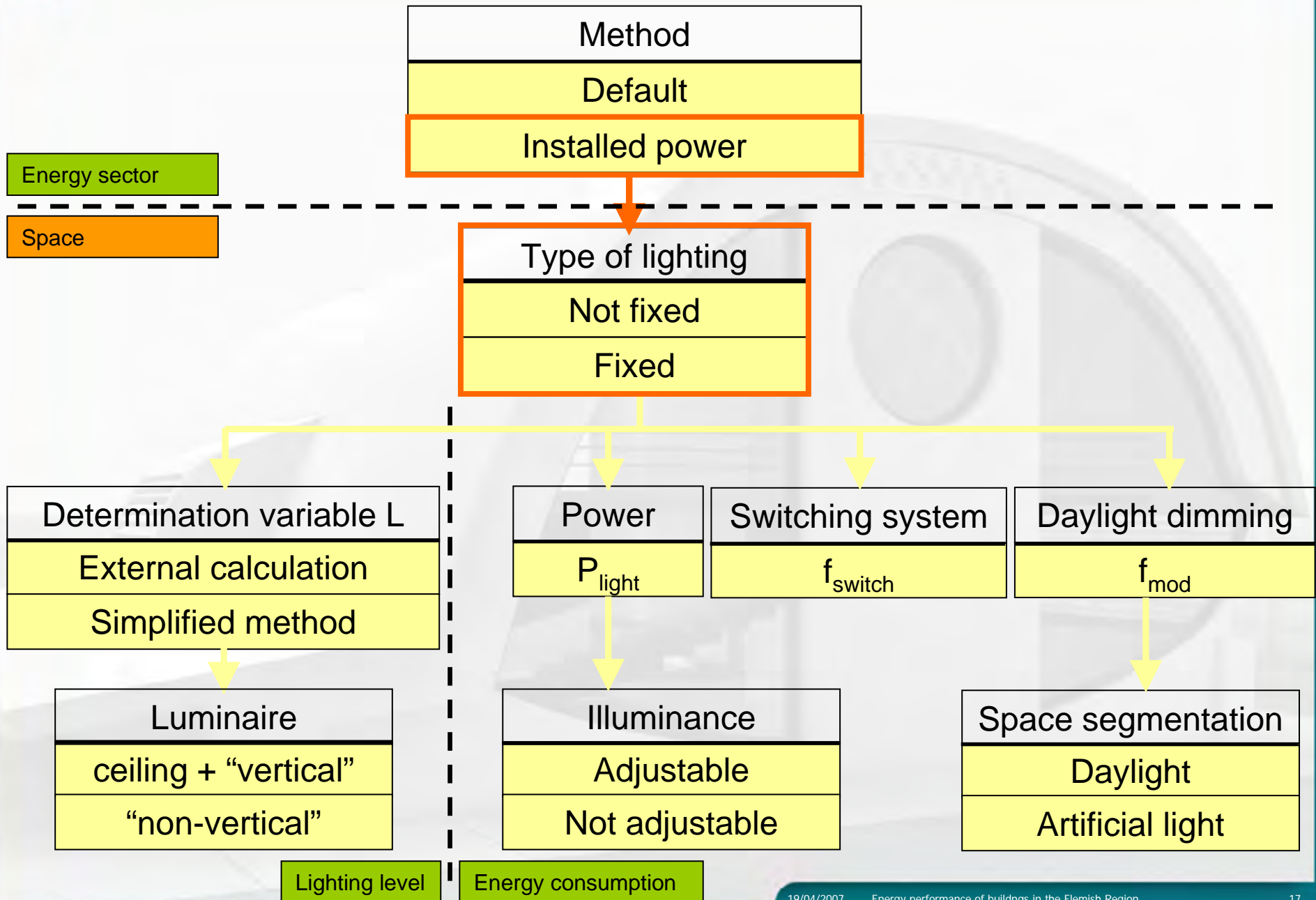
- Based on the installed powers

$L_{\text{rm r}}$ en $W_{\text{light, rm r}}$ calculated for each space

→ Principally more favourable



Lighting in the calculation method: flowchart





Lighting in the calculation method: type of lighting

❖ Characteristics have to be provided for each space

- In spaces without fixed lighting, predetermined values are used

- The same values as used for the default

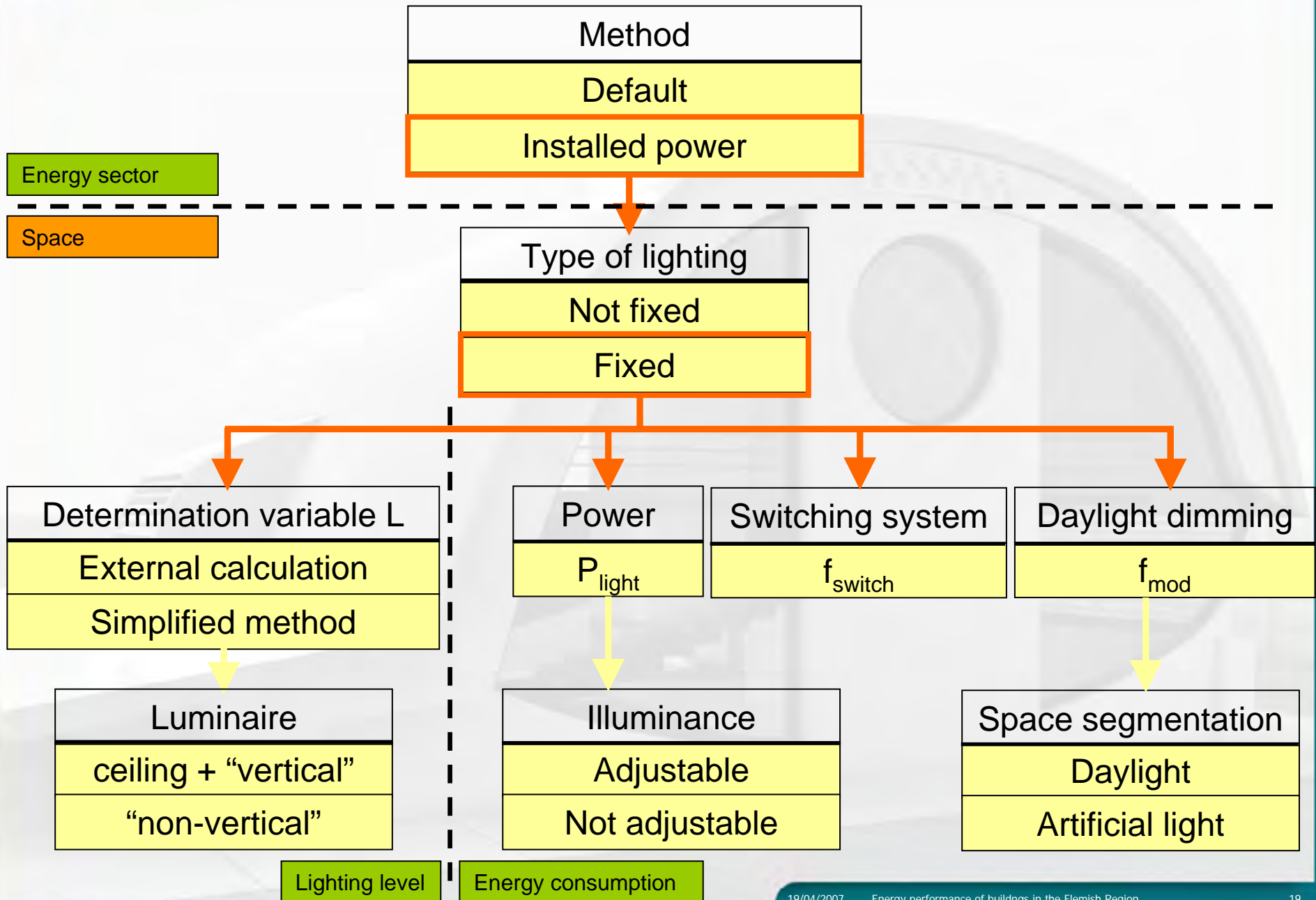
- calculation: $L_{rm\ r} = 500$

- $W_{light, rm\ r}$ for $20W/m^2$

- If fixed luminaires are used in the room (normal situation), installation characteristics have to be provided



Lighting in the calculation method: flowchart





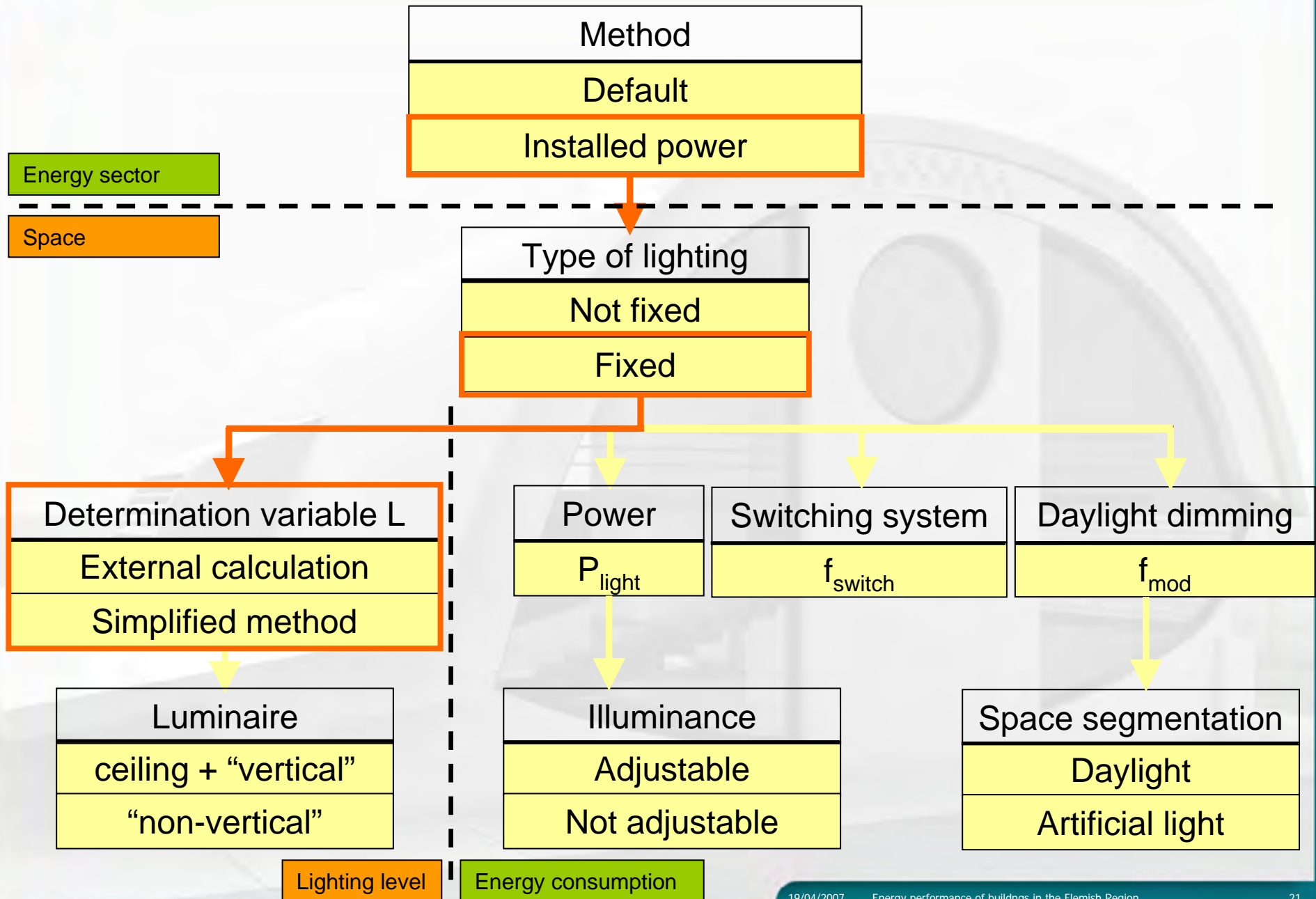
Calculation based on installed powers

❖ Calculation of:

- Dimensionless auxiliary variable L (denominator E level):
 - very rough estimation of illuminance
 - for a higher achieved illuminance, a higher energy consumption is allowed
- the annual lighting energy consumption (numerator E level)
 - **all** fixed luminaires and their characteristics
 - types of control
 - on/off switching
 - possibly daylight dimming
 - daylight supply



Lighting in the calculation method: flowchart





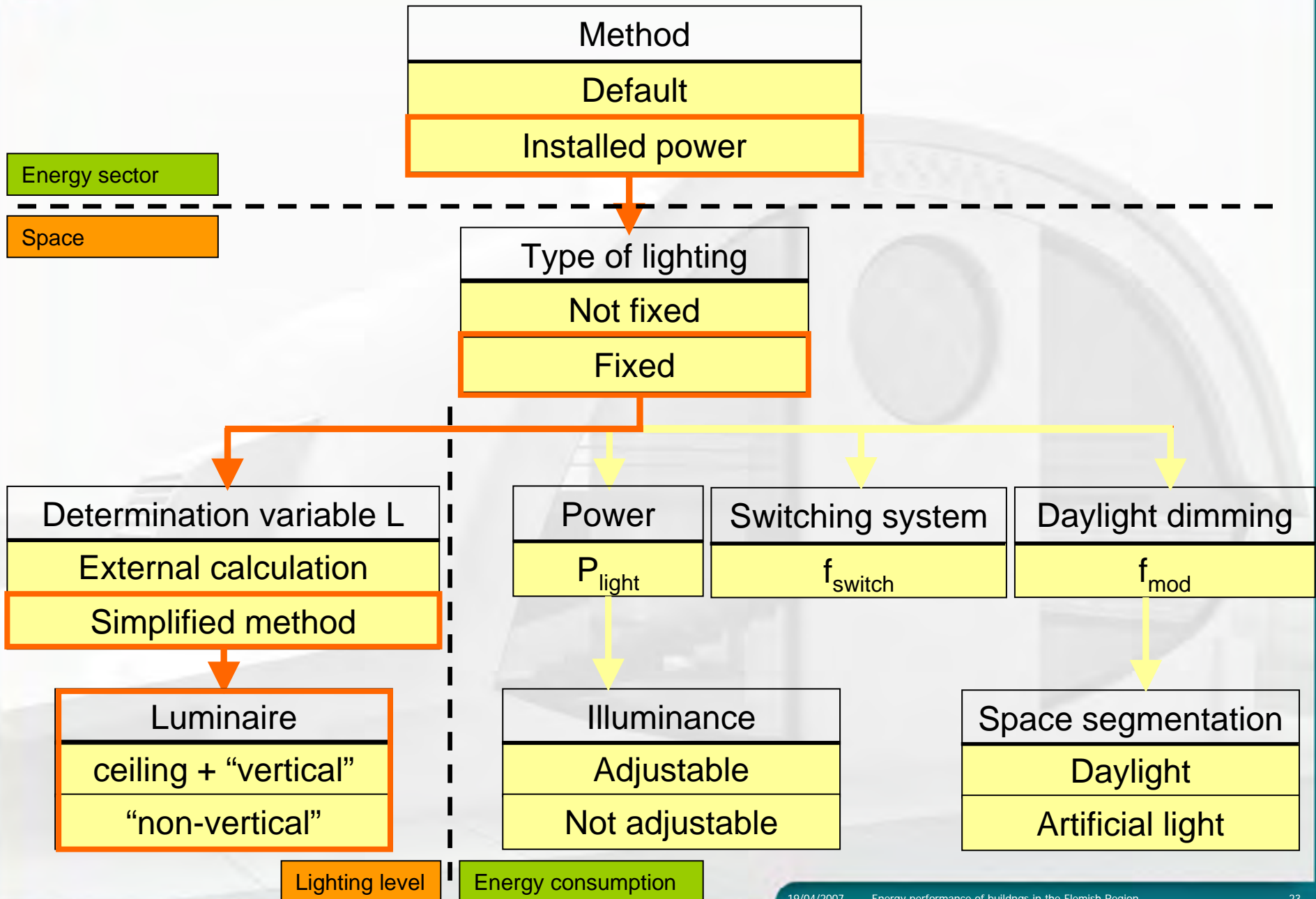
Determination of auxiliary variable L

❖ 2 options:

- or determination of illuminance with an detailed (external) calculation program
 - e.g. special systems that are underestimated when applying the simplified method
 - program has to be recognized by the government
- Or the simplified method based on the luminous flux of the lamps and the flux code of the luminaire
 - only applicable for ceiling luminaires that aim sufficiently downwards



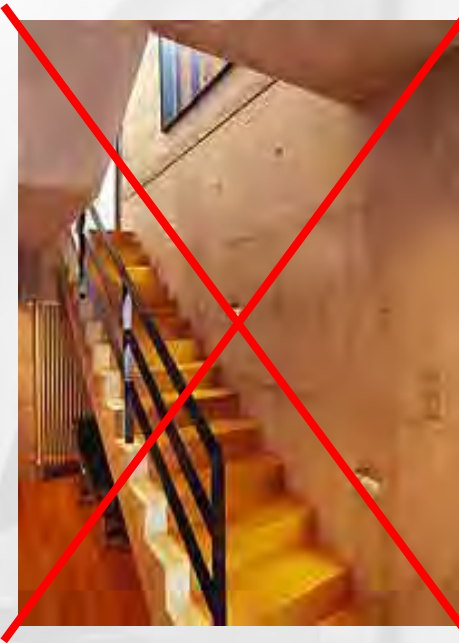
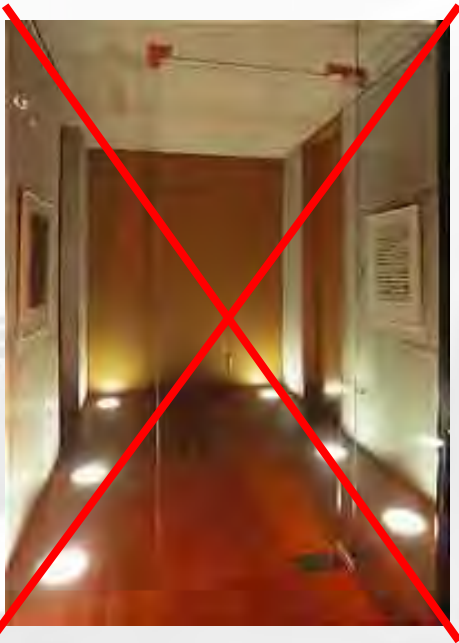
Lighting in the calculation method: flowchart





Luminaires which are not considered for the "simplified" L (1)

❖ Wall and floor luminaires



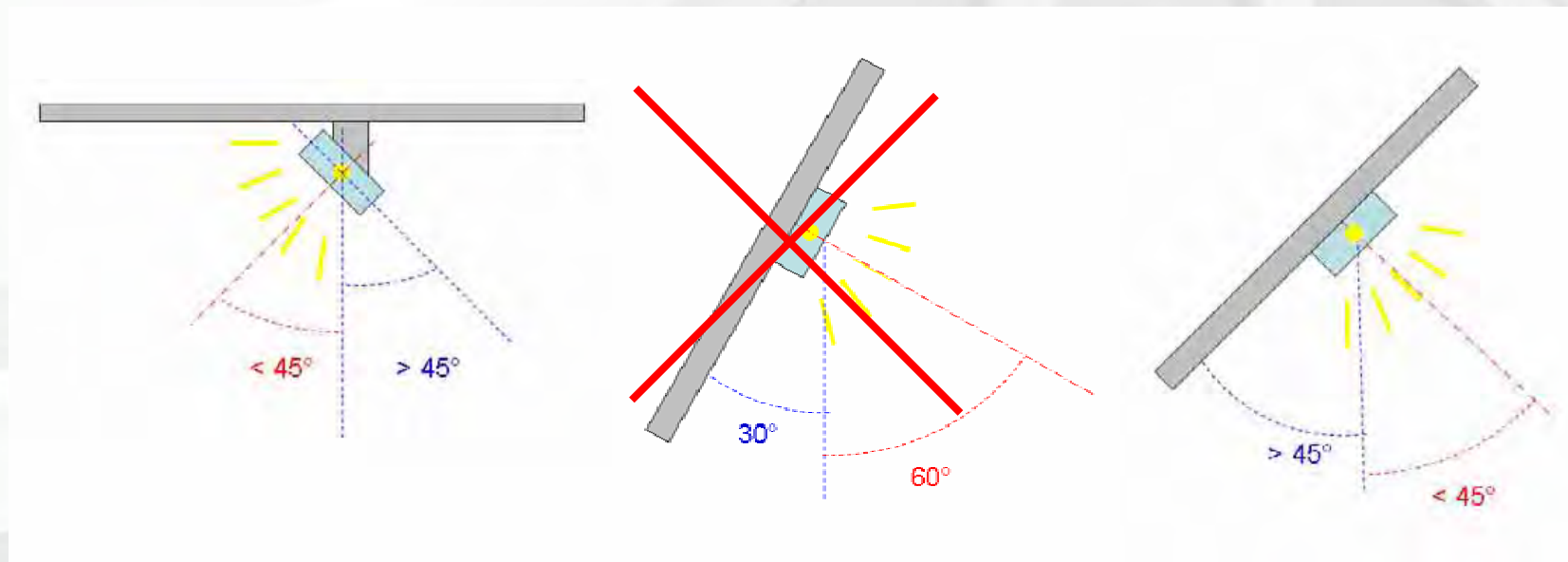
NOTE: The energy use of these luminaires has to be taken into account nevertheless!



Luminaires which are not considered for the “simplified” L (2)

Ceiling luminaires which don't aim downwards

Criterion : 45°



NOTE: The energy use of these luminaires has to be taken into account nevertheless!



Simplified determination of the auxiliary variable L

Necessary characteristics

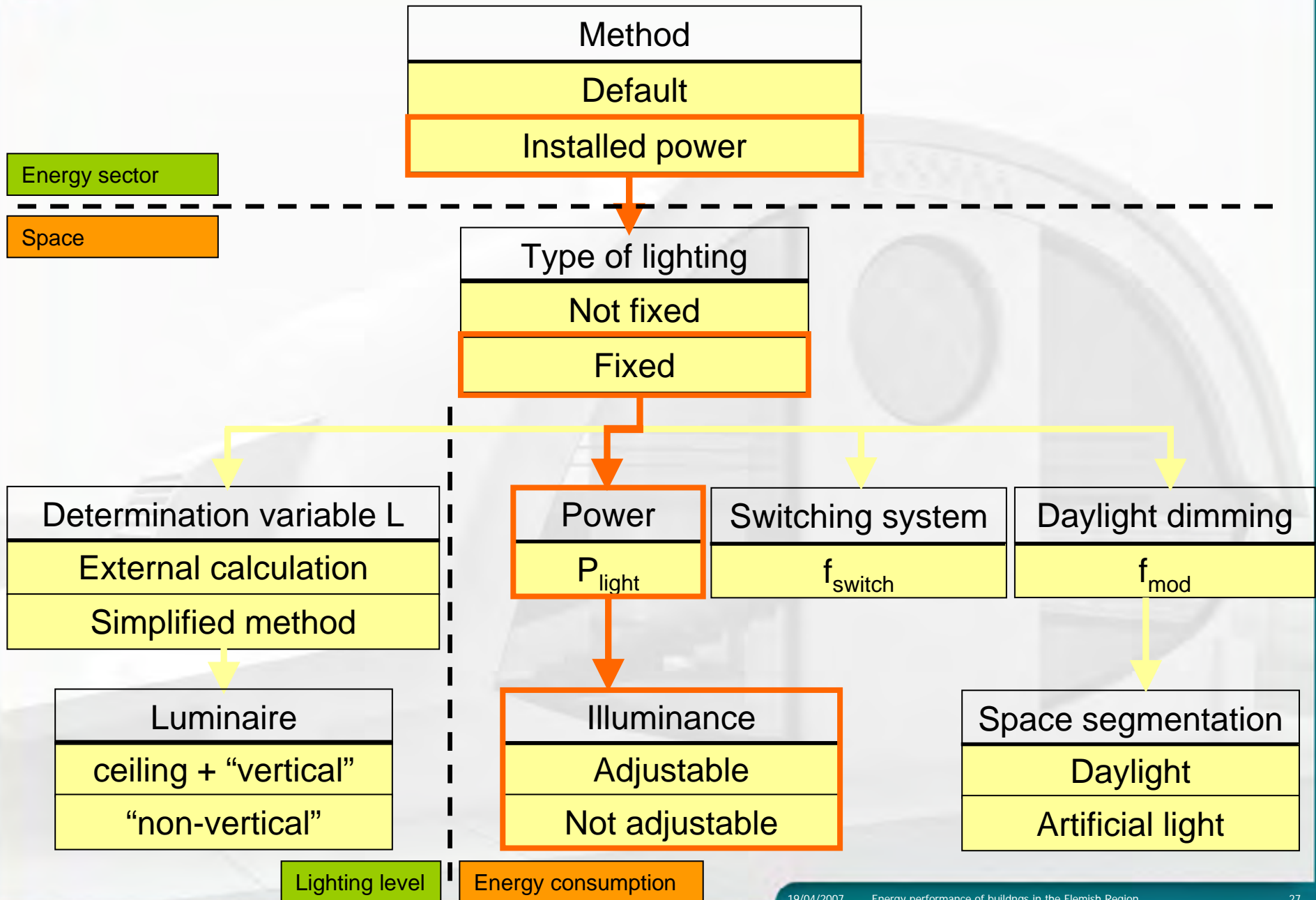
- ❖ number of lamps
- ❖ luminous flux per lamp (lumen)
- ❖ 3 numbers out of the CIE flux code
(total flux code is a set of 5 numbers: see further)
 - .N2
 - .N4
 - .N5

CIE flux code:

- ❖ definitions in CIE publicatie n°52 (1982)
- ❖ identical with the more recent CEN flux code (EN 13032-2:A-2004)



Lighting in the calculation method: flowchart





Lighting in the calculation method : P_{light}

❖ Power (Watt)

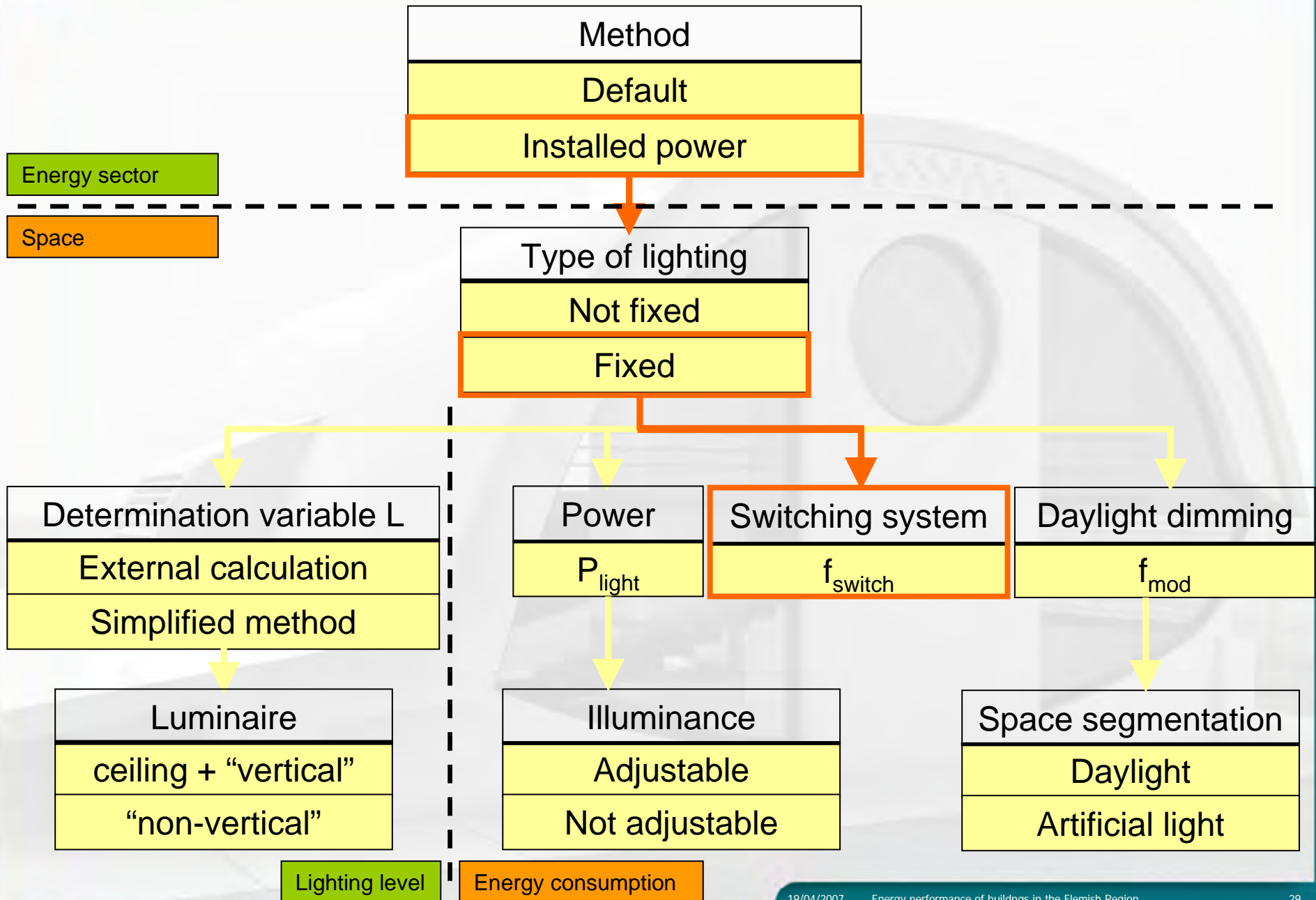
- calculation value for the nominal power of the lamps, included possible auxiliary devices, sensors, controls and/or switches of the luminaire

❖ Freely adjustable illuminance

- This means that the illuminance can be regulated
 - e.g. 1: at the moment of installation (light flux set-up by a technician)
 - e.g. 2: manual control of the luminous flux (by user, e.g. using a potentiometer)



Lighting in the calculation method: flowchart





Lighting in the calculation method : f_{switch}

❖ On/off switching

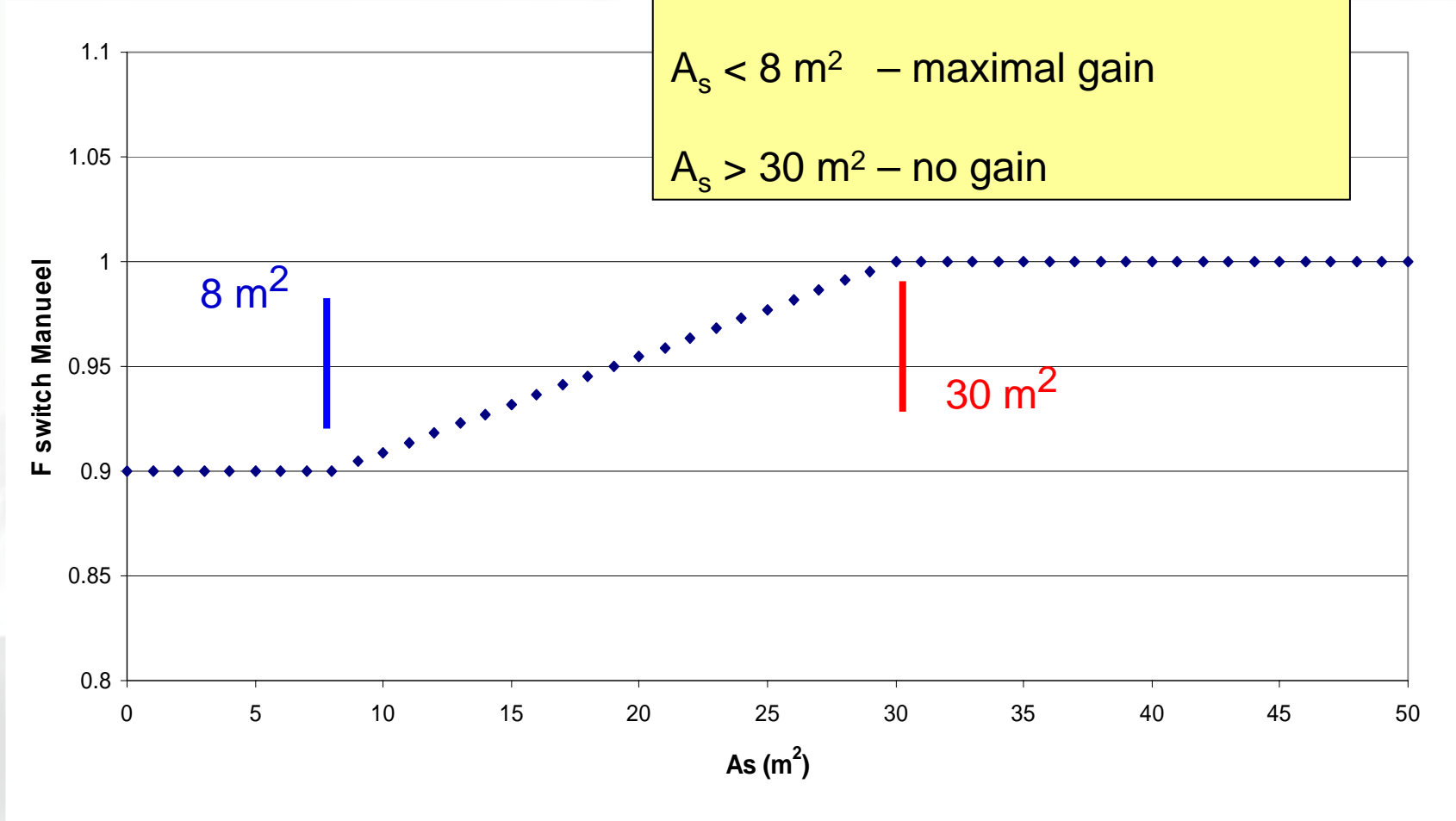
- reduction factor for the energy consumption
- in function of the system type
- (in function of the controlled surface A_s)



Lighting in the calculation method : f_{switch}

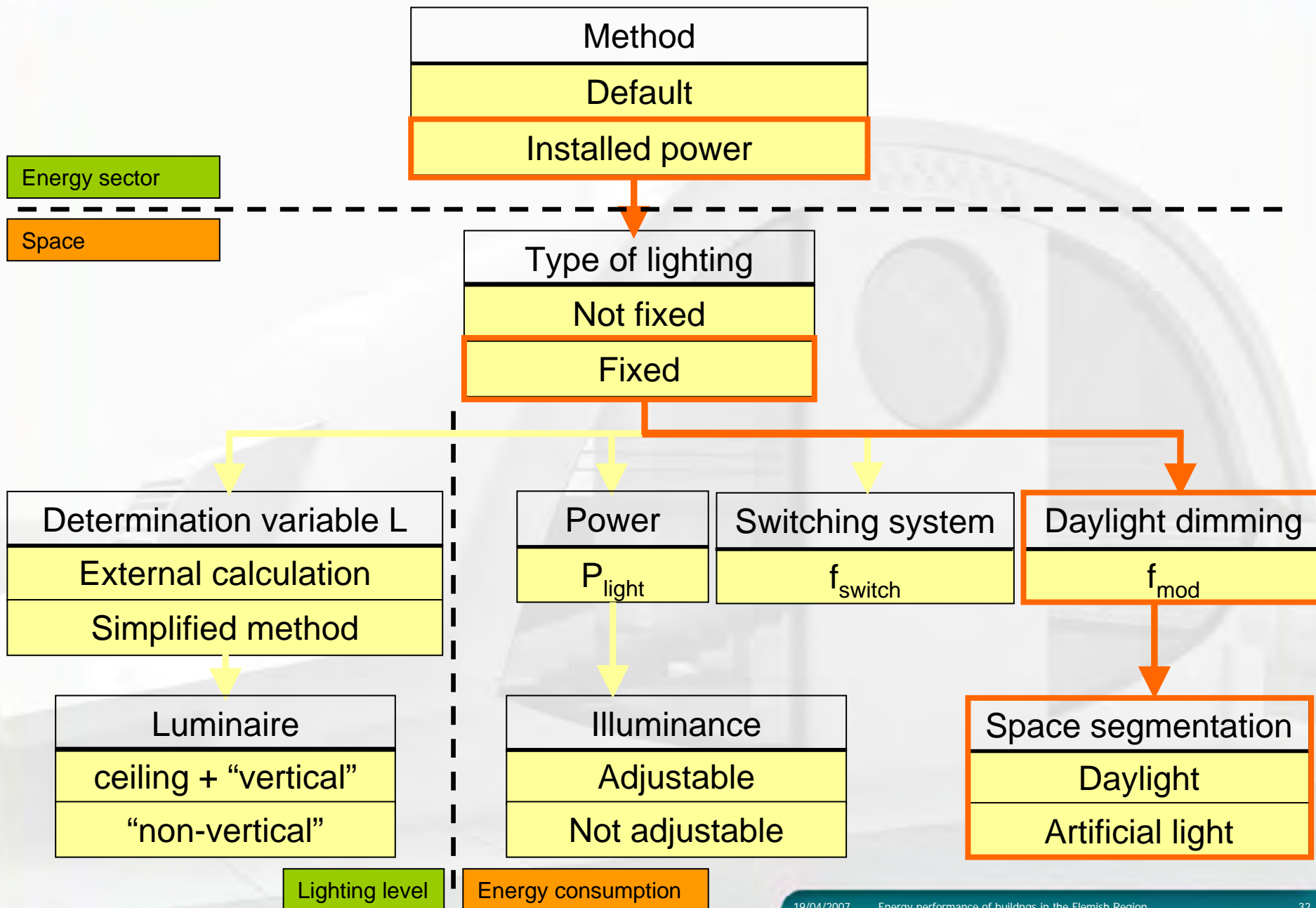
❖ f_{switch} – manual

2 thresholds :
 $A_s < 8 \text{ m}^2$ – maximal gain
 $A_s > 30 \text{ m}^2$ – no gain





Lighting in the calculation method: flowchart





Lighting in the calculation method: f_{mod}

❖ Modulating systems

- 2 different values

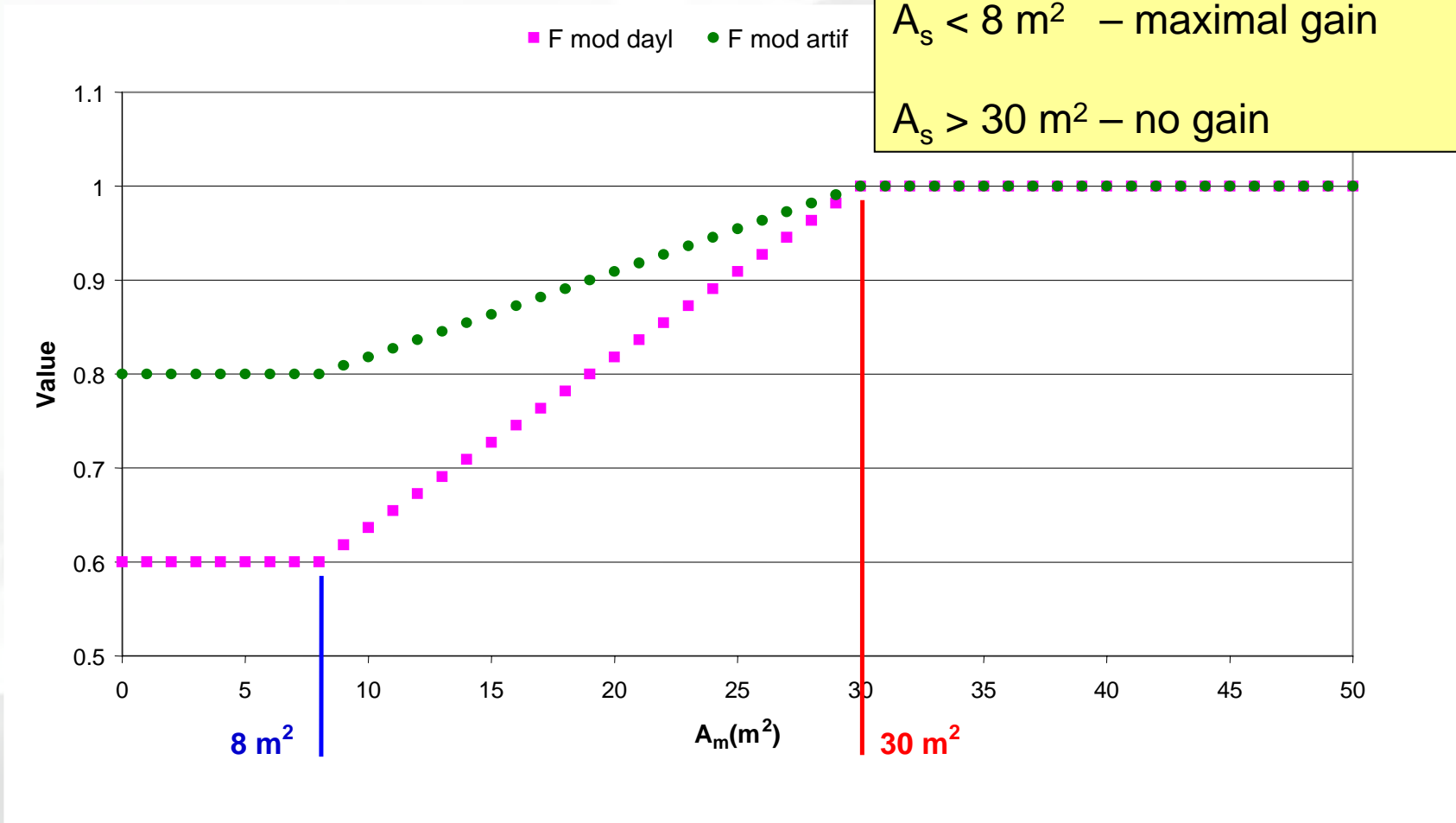
- f_{mod} artificial area → Artificial light zone
- f_{mod} daylight area → Daylight zone
- In function of the controlled surface A_m



Lighting in the calculation method: f_{mod}

❖ $f_{mod\ dayl}$ and $f_{mod\ artif}$

2 thresholds :
 $A_s < 8\ m^2$ – maximal gain
 $A_s > 30\ m^2$ – no gain



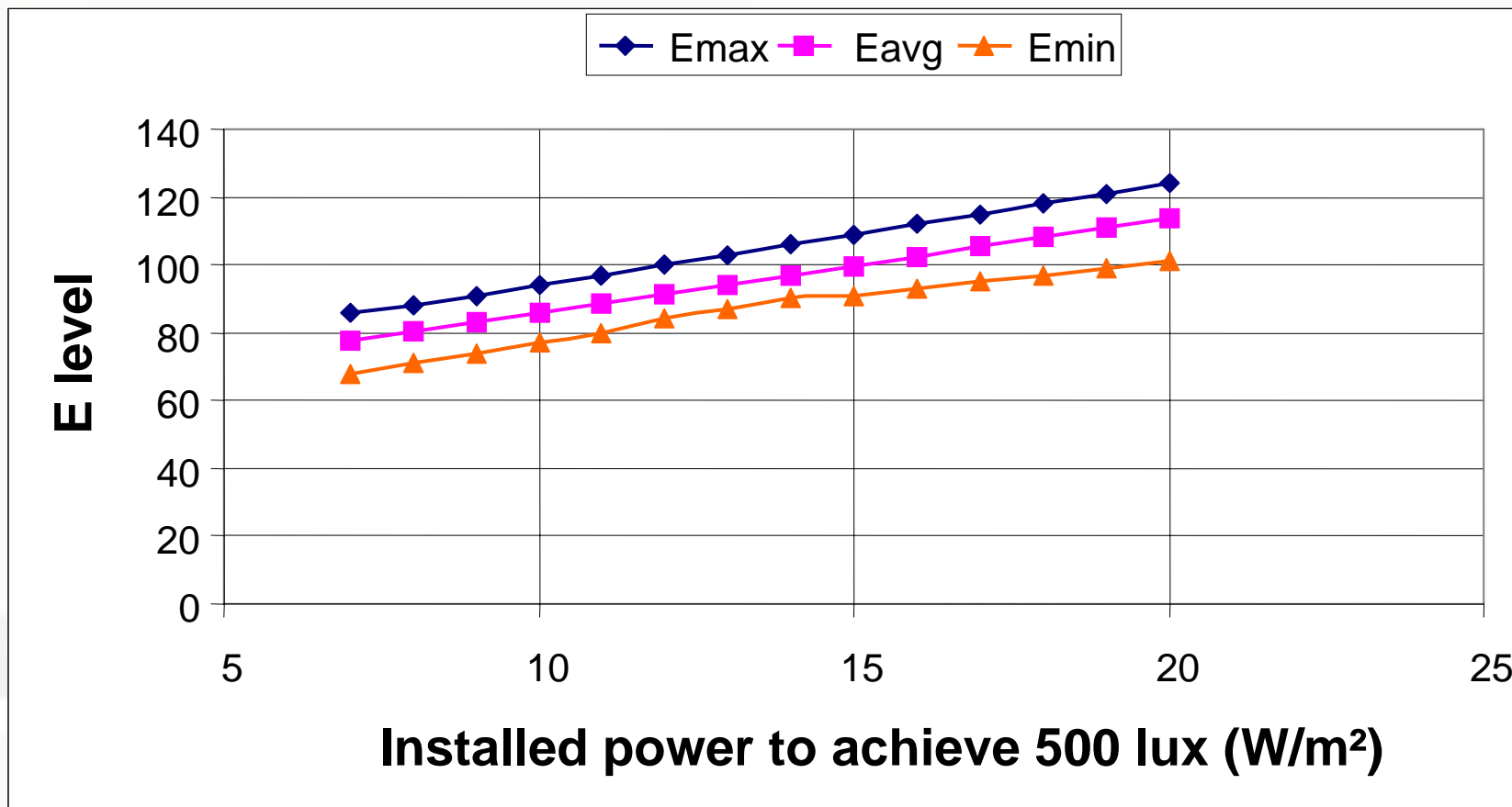


Lighting in the calculation method: influence factors

Factor	Depends on:	When other factors constant, the influence of this factor on the E level is:
Aux. variable L	<ul style="list-style-type: none">- Number of lamps- Luminous flux per lamp- Flux code	If the aux. variable increases, the E level will decrease
Electrical power	<ul style="list-style-type: none">- Power of the luminaire- Illuminance adjustable	If the installed power decreases, the E level will decrease
f_{switch}	<ul style="list-style-type: none">- System type- Controlled surface	If f_{switch} decreases, the E level will decrease
$f_{\text{mod, dayl}}$	<ul style="list-style-type: none">- System type- Controlled surface	If $f_{\text{mod dayl}}$ decreases, the E level will decrease
$f_{\text{mod, artif}}$	<ul style="list-style-type: none">- System type- Controlled surface	If $f_{\text{mod artif}}$ decreases, the E level will decrease



Sensitivity analysis of 50 offices: lighting



Default value (20 W/m²) compared to a more typical 12 W/m²:
average E112.1 compared to E89.5
→ a difference of about 20 “points”