WEii

PROTOCOL

An energy efficiency indicator based on the actual energy use of a building

Version 2.0
January 2022

A TVVL and DGBC initiative

Werkelijke Energie intensiteit indicator

For questions regarding the WEii protocol you can contact one of its authors via info@weii.nl

- Michiel van Bruggen, TVVL
- Eefje Stutvoet, DGBC
- Martin Mooij, DGBC

The following people have contributed ideas to the development of the WEii protocol:

- Huub Keizers, TNO
- Hein Jacobs, Jacobs Energieadvies
- Adriaan Woonink, TRAJECT Adviseurs en Managers
- René Koeslag, Rijksvastgoedbedrijf (RVB)
- Jeffrey Sipma, TNO
- Daniëlle Dikhoff, TVVL
- Andy van den Dobbelsteen, TU Delft
- Jaap Dijkgraaf, DWA
- Bert Elkhuizen, E-Nolis
- Erik Tober, RHDHV
- Ieke Kuijpers, DGMR
- Harm Valk, Nieman Raadgevende Ingenieurs
- Ronald Schilt, Merosch

Summary

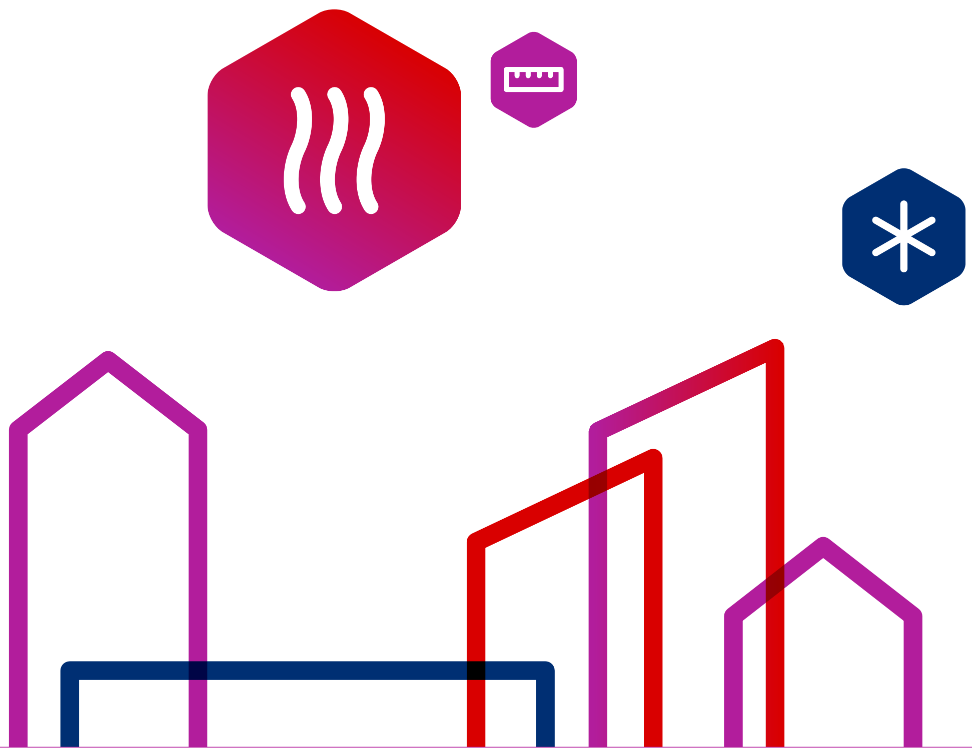
WEii is an acronym for the Dutch 'Werkelijk Energie intensiteit indicator' and stands for Actual Energy intensity indicator. It is a standardised methodology to determine an energy-efficiency indicator based on a building's actual energy use. Part of the methodology is a classification by energy efficiency classes of different types of buildings. The Truly Energy Neutral Building (WENG) and the Paris Proof are classes specified in this classification.

WEii refers to utility buildings and is based on the actual, measured energy consumption.

WEii is an addition to existing instruments such as the NTA 8800.

Other than the WEii indicator, the methodology describes supplementary indicators that can be helpful in assessing the efficiency of a building.

This protocol describes the scope of WEii, the determination method, and the energy efficiency classes.



Content

1 Terms

Occupancy rate
The occupancy rate is the average area of use per person required for the building function in question during operating hours.

Energy use
Energy use refers to the energy content of an energy carrier. Energy use can also refer to negative energy use (feed-in).

Energy-neutral
A building is energy neutral if the balance of energy purchase and energy feed-in of all relevant main meters over a year is equal to zero. This is based on average climate conditions.

Building
A building is a structure intended for people to stay. Generally, the building corresponds to the building definition in the municipal database addresses and buildings (BAG).

Building-related operational energy consumption
The energy consumption for: space heating, space cooling, ventilation, hot water, electricity for central installations and lightning. Lightning is only applicable for utility buildings because of the Energy Performance Calculation method.

User-related operational energy consumption
The energy used in a building that is not related to energy consumption to operate the building. For example, for kitchen and canteen appliances, TVs, copiers and computer equipment.

Space category
Use-related functional units are parts of a building that have the same intended use and together form a functional unit.

Usage intensity
Hours of usage per m^2 of usable floorspace per year.

Usable floorspace (Ag)
Usable floorspace in accordance with NEN 2580. The area measured at floor level, between ascending partition structures, enclosing the space or group of spaces concerned.

Operating hours
Operating hours are the hours per year that the building is in use.

Main meter
The main meter is the validated measuring device at the transfer point between the grid operator and the connected party. The energy consumption recorded by the main meter is, in most cases, one of the parameters for determining the WEii indicator.

Interval measurement
Measurement of energy consumption at fixed intervals based on remotely readable meters. Typically, the interval is a quarter of an hour for electricity and one hour for gas.

Paris Proof
Paris Proof is the collection of final targets set by the DGBC for different types of buildings within the framework of the objectives of the Paris Agreement. The unit of these final targets is kWh/m^2, determined in accordance with this protocol.

Building unit
The smallest unit of use situated within one or more buildings and suitable for residential, commercial or recreational purposes, with access via its own lockable access from the public road, a yard or a shared traffic area, may be the subject of legal acts relating to property law and is functionally independent.

Hours of occupancy
Hours of occupancy are determined as the sum of the time (per person) that people spend in the building.

2 Symbols

Symbol	Meaning	Unit
WEii	Actual Energy intensity indicator	kWh/m^2
E	Net normalised energy use of building per year	kWh/year
A_g	Usable floorspace	m^2
f_i	Correction factor usage intensity	-
f_{cor}	Normalising constant relating to weather conditions	-
$E_{in;ci}$	Energy supply per year for energy carrier ci	kWh/year
$E_{out;ci}$	Energy feed-in per year for energy carrier ci	kWh/year
$E_{prod;ci}$	Locally produced energy per year for energy carrier ci	kWh/year
$E_{excl.}$	Energy use related to excluded energy functions	kWh/year
I	Actual usage intensity	h/m^2 • year

3 Introduction

WEii is an acronym for the Dutch 'Werkelijke Energie intensiteit indicator' and stands for Actual Energy intensity indicator. It is a standardised methodology to determine an energy-efficiency indicator based on a building's actual energy use.

In contrast to NTA 8800, WEii is based on the actual energy use of a building in use, and not on a calculated value of the building-related operational energy consumption.

Together with the determination methodology, energy efficiency classes have been developed for the various building types. The most ambitious classes are **Paris Proof**, for a building that meets the 2050 objectives, and **Truly Energy Neutral** (WENG) for a building that produces the same amount of energy per year as it consumes.

Other than the WEii indicator, the methodology describes supplementary indicators that can be helpful in assessing the efficiency of a building.

This report describes the determination method of the WEii indicator and the classes of energy efficiency for the different building types.

Chapter 4 discusses the delimitation of the WEii indicator, both in terms of content and target group. Chapter 5 describes how to determine the WEii indicator. Chapter 6 describes the classes of energy efficiency. Chapter 7 describes other indicators.

4 Delimitation

4.1 Starting points

The WEii of a building is expressed in kWh/m², is based on the actual energy consumption, and is a measure of the true energy efficiency of a building. The WEii can be determined at two levels of detail:

- basic method based on the minimum information required to determine the WEii.
- detailed method with several optional refinements to the WEii.

General

1. The WEii is intended for existing non-industrial and non-residential buildings. In general, these are buildings whose primary purpose is to accommodate people comfortably. Hereby, a distinction is made between different types of buildings.

2. WEii falls under the sphere of influence of building owners and/or builing users. WEii only changes if alterations take place in the building itself or to the users of the building. WEii does not change becasue of alterations in external factors such as sustainable improvements of the power grid.

3. The WEii refers to one building or one building unit.

4. A building or building unit can accommodate several spatial functions.

5. The WEii refers to the actual measured energy consumption over one calendar year. In the case of feed-in, supply and feed-in will be netted over one year.

6. The WEii is determined based on the measured energy consumption and the usable floorspace (Ag) of the building.

7. The WEii has the value 0 for a True Energy Neutral Building. With a value higher than zero, more energy is supplied to the building than is fed in. With a value below zero, more energy is fed in than is supplied.

8. For each type of building, there is a classification with seven classes: from energy neutral to very inefficient. **Truly Energy Neutral Building** (WENG) and **Paris Proof** are part of this classification.

Detailed method

9. This is a detailed method of determination that takes into account excluded energy use, weather conditions, and usage intensity. All additional elements of this detailed method are optional.

Other indicators

The other indicators are informative. The following indicators are described:

- **Gross energy efficiency:** efficiency of consumption without local generation
- **Coverage of local generation:** the extent to which local generation covers energy needs.
- **Usage intensity:** efficiency related to the usage intensity of the building.
- **Gas Consumption:** Actual gas consumption in m^2
- **CO_2 emissions:** derived from energy consumption.

4.2 Scope

The WEii is intended for existing non-industrial and non-residential buildings. In general, these are buildings whose primary purpose is to accommodate people comfortably. The target group coincides with the target group for the energy label for non-industrial buildings. WEii devided the usage functions from the Dutch building decree into 24 types of buildings.

4.3 Building

4.3.1 Building boundaries

The most essential starting point for the demarcation of the building boundaries is the registration of a building and/or a building unit in the municipal database addresses and buildings (BAG).

A building in BAG relates to a building, a building unit relates to the independent units present in the building. There may be more than one building unit in one building. The WEii may relate to

- a building;
- a building unit;
- a group of building units within a single building.

A building or building unit can accommodate several space categories.

The building may also comprise other facilities on the plot,
such as a solar energy system.

4.3.2 Usable floorspace

The usable floorspace (Ag) is defined in accordance with NEN 2580.

The usable floorspace corresponds to the usable floorspace registered the BAG or the usable floorspace stated on the energy label.

If the usable floorspace stated in the BAG is demonstrably not correct, it can be deviated from.

If there are several building types, the usable floorspace can be determined for each building type. Based on the usable floorspace per building type, weighted average class limits can be determined (see also paragraph 4.3.3 and the example in chapter 6).

The usable floorspace of the building can be reduced by the usable floorspace that is used for irregular space categories. See also paragraphs 4.4.1 and 5.2.3.

4.3.3 Space category and building type

The space categories to be used with the WEii correspond to the space categories listed in the BAG (see also Table 5). If the space category stated in the BAG is demonstrably not correct, it can be deviated from.

The building type is chosen in accordance with the current use of the building.

The energy efficiency class of a building with multiple building types can be determined by establishing new class boundaries for this building based on the weighted average of the class boundaries of those classes that correspond to the building types concerned (see example chapter 6).

4.4. Energy

WEii refers to the energy efficiency of the building. When determining WEii, only energy consumption or energy production within the building or plot boundaries is considered. It is therefore undesirable for WEii to change if the energy supply to which the building is connected becomes more efficient. When determining the WEii, renewable energy generated (or purchased) outside the plot boundaries is not taken into account.

Heat and cold supply is considered part of the national energy supply. To give the heat and cold supply in WEii an equal position, nationally representative efficiency factors are used. The efficiency factors for heat and cold supply are based on the current best-practice technology within buildings, namely heat/cold storage with a heat pump in accordance with ISSO 39. The factor ensures that buildings with an individual energy supply are classified as buildings with a collective heat or cold supply. must achieve the same energy saving level in order to achieve the same ambition level or WEii class.

Energy use or production based on energy carriers is converted to kWh on the basis of the conversion and efficiency factors given in Table 1.

Table 1: Energy and efficiency factors

Energy carrier	Energy factor [kWh/unit]	Efficiency factor [-]
Natural gas	9.77 (kWh/m^3)	1
Electricity	1 (kWh/kWh)	1
Heat	278 (kWh/GJ)	0.33
Cold	278 (kWh/GJ)	0.10
Biomass solid	4.19 (kWh/kg)	1
Hydrogen	3.0 (kWh/m^3)	1

For other energy carriers, the net calorific value from the fuel list of the year for which the WEii has been determined can be used[1].

4.4.1 Excluded energy use

If there is energy use for functions that are not related to the regular functions in non-industrial buildings, the energy use of the building may be reduced by these amounts of energy. See also paragraph Excluded energy use 5.2.3.

[1] Dutch list of energy carriers and standard CO_2 emission factors, version year xxxx, RVO

4.5. Required data

Table 2 contains the technical data needed to determine the WEii and the other indicators. The minimum information required is shown in bold.

Table 2: Data needed to determine the WEii and other indicators. X(d) means that this information relates to an optional detailed calculation.

	WEii	Gross consumption	Coverage	Usage intensity
Usable floorspace	**X**	X		
Delivered energy per energy carrier per year	**X**	X	X	X
Energy returned to the grid per energy carrier per year	**X**	X	X	X
Excluded usable floorspace	X(d)	X(d)	X	X(d)
Excluded energy use per energy carrier	X(d)	X(d)		X(d)
Degree days from nearby weather station	X(d)	X(d)		X(d)
Solar radiation from nearby meteor station	X(d)	X(d)		X(d)
Hours of occupancy				X
Locally produced renewable electricity per year		X	X	

In addition to the technical data, administrative data such as address and space category are required.

5 WEii

5.1 Basic method

5.1.1 Introduction

The WEii is defined as the energy consumption per m² of usable floorspace.

5.1.2 Definition

The WEii is determined as follows:

$$WEii = \frac{\sum_{ci} E_{in;ci} - \sum_{ci} E_{out;ci}}{A_g}$$ [kWh/m² • year] **Equation 1**

waarin:

$WEii$	The Indicator	[kWh/m² • year]
$E_{in;ci}$	Energy supply per year for energy carrier ci.	[kWh/year]
$E_{out;ci}$	Energy feed-in per year for energy carrier ci.	[kWh/year]
A_g	Usable floorspace	[m²]

The WEii is rounded to an integer.

The energy consumption per energy carrier (natural gas, electricity, bio-energy, etc.) has been converted to kWh using the energy and efficiency factors in paragraph 4.4.

Example 1

Given office building with:

Usable floorspace	12,000 m²
Electricity consumption	780,000 kWh/year
Natural gas consumption	69,000 m³/year

Table 3: Simple example WEii indicator calculation.

1	Electricity	780,000	780*10³ kWh
2	Natural gas	69,000*9.77	674.82*10³ kWh
3	Total	(1+2)	1,454.13*10³ kWh
4	A_g		12,000 m²
5	Indicator	3/4	121 kWh/m²

5.2 Detailed method

5.2.1 Introduction

The calculation with the basic method can be refined with the detailed method as follows:

- Excluding foreign energy consumption (energy consumption that does not form part of the space category of the building).
- Valuing the efficiency of the energy supply.
- Normalising energy consumption for weather-dependent energy functions.
- Valuing the usage intensity of the building.

Deze elementen zijn individueel facultatief te betrekken in de berekening van WEii.

5.2.2 Definition

The indicator is determined as follows:

$$WEii = \frac{\sum_{ci} E_{in;ci} - \sum_{ci} E_{out;ci} - \sum E_{excl} + \sum_{efun} E_{cor}}{A_g}$$

[kWh/m² • year] **Equation 2**

in which:

$WEii$	The indicator	[kWh/m² • year]
$E_{in;ci}$	Energy supply per year for energy carrier ci.	[kWh/year]
$E_{out;ci}$	Energy feed-in per year for energy carrier ci.	[kWh/year]
$E_{excl.}$	Corrections related to excluded energy use (see par 5.2.3)	[kWh/year]
E_{efun}	The use of energy for a specific energy function, such as heating, for example.	
E_{cor}	Corrections related to the normalisation of energy use for energy function efun (see par 5.2.4).	[kWh/year]
A_g	Usable floorspace	[m²]

The WEii is rounded to an integer.

5.2.3 Excluded energy use

If there is energy use for functions that are not related to the regular functions in non-industrial buildings, the energy use of the building may be reduced by these amounts of energy.

This includes, for example, the following functions:

- A charging station for electric transport;
- An industrial function (other than company halls), a workshop, an atelier.
- A datacentre exceeding the building.
- A parking facility (interior or exterior).

The energy consumption of an excluded energy function can only be excluded if it is completely under-measured or can be derived/separated completely from other measurements.

If an excluded energy function occupies a certain part of the usable floor space of a building, , then the usable area must be exclusive of the area of this function.

5.2.4 Normalised energy use

Normalising energy use or energy production is relevant when the amount of energy used is highly dependent on specific weather conditions. Normalisation converts energy consumption into energy consumption in standardised weather conditions.

The aim of normalisation is to ensure that the WEii does not move with varying weather conditions. By normalising, the WEii can be objectively compared between different years, or between buildings in regions with different weather conditions. This is particularly relevant with regards to the benchmark associated with WEii.

The energy functions to be normalised are:

- energy use for heating;
- solar electricity production;

For correction purposes, the WEii management organisation determines yearly normalisation constants per reference weather station, per energy function. The reference weather stations are given in Appendix 1.

In general, normalisation is done as follows:

1. Select the nearest weather station based on the instructions in Appendix 1. This weather station is the reference weather station for the building.
2. Determine the normalisation constant. This factor is specific to the reference weather station and the corresponding energy function.
3. Determine the (measured) energy consumption for this energy function.
4. Determine the correction for this energy function by multiplying the normalisation constant with the measured energy use for this energy function.

$$E_{cor} = f_{cor} * E_{efun}$$ [kWh/year] **Equation 3**

in which:

E_{cor}	The correction of the total energy consumption.	[kWh/year]
E_{efun}	Measured energy consumption for the energy function.	[kWh/year]
f_{cor}	Normalisation constant related to the energy function in question.	[-]

Note 1: The normalised energy use for the energy function in question is given by $(1+f_{cor}) * E_{efun}$.

Note 2: If the normalisation constant is less than 0 then, in the case of heating, it was colder in the year in question than in the reference year.

Example: Given a measured heat consumption of 30,000 kWh and a normalisation constant of -0,05. The correction then is -0.05*30,0000 kWh= -1,500 kWh.

6 Energy efficiency classes

WEii energy efficiency classes are distinguished per building type.

Buildings are classified according to the numerical value of the WEii in the classes given in Table 4.

Tabel 4: WEii classes.

Denomination
Truly energy neutral (WENG)
Paris Proof (DGBC)
Very economical
Economical
Average
Uneconomical
Very uneconomical

The class **Truly energy neutral** applies to buildings with a WEii of 0 kWh/m^2 or less.

The **Paris Proof** class is based on the target values set by the Dutch Green Building Council for achieving the 2050 objective of the Paris Accord. The numerical value of the Paris Proof target per building type is based on the assumption that with the expected available quantity of renewable energy in 2050, all buildings can be supplied with energy if the buildings have an energy use that is at most equal to the Paris Proof numerical values. This would meet the objective of the Paris Accord and the Dutch climate agreement.

The numerical values for the class for the different types of buildings are given in Table 5.

Table 5: Upper limits in kWh/m² of the WEii classes based on the ECV study energy metrics.

Use functions Building code	Building types WEii	WENG	Paris Proof	Very economical	Economical	Average	Uneconomical	Very uneconomical
Meeting function	Restaurant	0	200	270	415	695	1075	-
Meeting function	Café	0	70	90	140	250	450	-
Meeting function	Childcare	0	50	80	130	195	285	-
Meeting function	Sauna	0	160	200	300	500	1330	-
Meeting function	Other	0	70	90	130	245	415	-
Cell function	Cell building	0	100	130	200	340	590	-
Health care function with overnight stay	Hospital	0	100	135	185	315	500	-
Health care function with overnight stay	Care home with overnight stay	0	80	115	160	285	455	-
Health care function without overnight stay	Medical (group) practice	0	80	110	150	270	420	-
Health care function without overnight stay	Daycare without overnight stay	0	90	115	170	290	490	-
Industrial function	Production hall	0	50	60	95	160	260	-
Industrial function	Cold store	0	85	115	170	295	450	-
Industrial function	Car garage/showroom	0	70	90	140	250	400	-
Office function	Office	0	70	100	150	230	330	-
Accommodation function in accommodation building	Hotel	0	110	140	210	375	640	-
Accommodation function	Holiday park	0	70	90	140	250	425	-
Educational function	Primary / Secondary education	0	60	85	120	165	290	-
Educational function	University/Higher vocational training/Intermediate vocational training	0	70	90	125	225	380	-
Sports function	Indoor sports accommodation	0	70	90	140	245	435	-
Sports function	Outdoor sports facilities	0	80	95	160	280	515	-
Sports function	Swimming pool	0	210	300	430	765	1365	-
Shop function	Shop with goods refrigeration	0	150	175	300	525	925	-
Shop function	Shop without goods refridgeration	0	80	100	165	290	520	-

To determine the energy efficiency class for buildings consisting of several different use functions, a 'tailor-made classification' can be made by determining the weighted average of the class boundaries of the relevant use functions.

Example

A building comprises two different space categories: 2000 m^2 shop function without goods refrigeration and 3000 m^2 office function. The class boundaries for this building are determined by the weighted average of the class boundaries of shop function without goods refrigeration and office buildings, see Table 6.

Table 6: Determination of 'tailor-made' class boundaries for a building with mixed functions in usable floor space.

	Shop function without goods refrigeration [kWh/$m^2 \cdot a$]	Office [kWh/$m^2 \cdot a$]	Average [kWh/$m^2 \cdot a$]
WENG	≤ 0	≤ 0	≤ 0
Paris Proof	≤ 80	≤ 70	≤ 74
Very economical	≤ 100	≤ 100	≤ 100
Economical	≤ 165	≤ 150	≤ 156
Average	≤ 290	≤ 230	≤ 254
Uneconomical	≤ 520	≤ 330	≤ 406
Very uneconomical	> 520	> 330	> 406

7 Other indicators

7.1 Gross energy efficiency

In the case of local energy generation, the WEii provides insight into the energy efficiency, including the effect of local energy generation (with possible offsetting of supply and feed-in). To gain insight into the efficiency of energy use in the building, the effect of local generation must be omitted from the calculation.

The gross energy efficiency is given by:

$$WEii_{bruto} = \frac{\sum_{ci} E_{in;ci} - \sum_{ci} E_{out;ci} + \sum_{ci} E_{prod;ci}}{A_g}$$ [kWh/m² • year] **Equation 4**

in which:

$WEii_{bruto}$	Gross WEii	[kWh/m² • year]
$E_{in;ci}$	Energy supply per year for energy carrier ci.	[kWh/year]
$E_{out;ci}$	Energy feed-in per year for energy carrier ci.	[kWh/year]
$E_{prod;ci}$	Energy production per year for energy carrier ci	[kWh/year]
A_g	Usable floorspace	[m²]

7.2 Coverage ratio

The coverage ratio indicates the extent to which the local energy production which is used directly in the building is able to meet the energy needs of the building.

The coverage ratio is given by:

$$f_{coverage} = \frac{\sum_{ci} E_{prod;ci} - \sum_{ci} E_{out;ci}}{\sum_{ci} E_{in;ci} - \sum_{ci} E_{out;ci} + \sum_{ci} E_{prod;ci}} * 100\%$$ [%] **Equation 5**

in which:

$f_{coverage}$	Coverage local generation.	[%]
$E_{in;ci}$	Energy supply per year for energy carrier ci.	[kWh/year]
$E_{out;ci}$	Energy feed-in per year for energy carrier ci.	[kWh/year]
$E_{prod;ci}$	Energy production per year for energy carrier ci	[kWh/year]

Example

Local energy production (electricity)	5,000 kWh
Feed-in (electricity)	3,038 kWh
Electricity supply	6,394 kWh
Gas supply	800 m^3

Elaboration:
$E_{in} = 6{,}394+800*9.77 = 14210 \text{ kWh}.$

$$f_{coverage} = \frac{5000-3038}{14210+5000-3038} * 100\% = 12\%$$

Usually, this indicator is used only for the coverage of electricity use; in this version, the indicator is based on total energy use, including other energy carriers.

For a pure definition, this indicator should also include the sustainable share of heat and/or cold use. As it is usually more difficult to determine, it is not included in this definition.

7.3 Usage intensity

The WEii is expressed in kWh/m^2-a. The usable floorspace in this unit is the performance measure for energy consumption. It is desirable that the intensity with which a building is used by people is reflected in its energy performance. After all, the true performance of an (office) building is not the heating and lighting of the square meters in the building, but the comfortable accommodation of people. This can be expressed in terms of energy efficiency in relation to the usage intensity.

Valuation of the usage intensity is based on hours of occupancy. The hours of occupancy are determined as the sum of hours over one year that each person stays in the building. Valuation of usage intensity is only used if this information is known on the basis of measurement.

By way of illustration: The measured hours of occupancy are 22,100 hours. This corresponds to an office where 10 people are present every working day from 9:00 a.m. to 5 p.m.. 10 (persons)* 8.5 (hours) * 5 (working days) * 52 (weeks) = 22,100 hours.

The hours of occupancy are converted to full time units using 1,760 hours as the reference number for the number of full-time hours per year.

The WEii for usage intensity is calculated by dividing the actual energy consumption (as calculated for the WEii by the hours of occupancy.

$$WEii_g = \frac{E * 1760}{t_{occupancy}}$$ [kWh/fte] **Equation 6**

$WEii_g$ is determined to two decimal places.
in which:

$WEii_g$	WEii for the usage intensity.	[kWh/h]
E	Measured (netted) energy consumption of the building.	[kWh/year]
1760	Reference numbers for number of hours per fte	
$t_{occupancy}$	Hours of occupancy	[h/a]

Example
Office building, the hours of occupancy have been measured to be 756,000 hours; the actual (possibly netted) energy consumption is $1454.8*10^3$ kWh/a

$$W_g = \frac{1454800 * 1760}{756000} = 3387\ kWh/fte$$

7.4 Gas consumption

WEii provides insight into energy efficiency based on the total energy consumption in the building. In order to be able to manage separately on gas reduction, the gas consumption indicator provides insight into the gas consumption per m^2.

The gas consumption is represented by:

$$WEii_{gas} = \frac{E_{gas} - E_{excl;gas} + E_{efun;heating} E_{cor}}{A_g}$$ **Equation 7**

waarin:

$WEii_{gas}$	Gas consumption per m^2	[kWh/m^2 • year]
E_{gas}	Annual energy supply for energy carrier gas	[kWh/year]
$E_{excl;gas}$	Correction related to excluded gas use	[kWh/year]
$E_{efun;heating}$	The use of energy for the energy function heating	[kWh/year]
E_{cor}	Correction related to the normalisation of energy use for heating	[kWh/year]
A_g	Usable floorspace	[m^2]

7.4 CO_2 emissions

The energy consumption of the building can be used to calculate the CO_2 emissions related to the energy consumption of the building. The calculation is the same as the calculation of WEii, instead of the energy conversion factors, the CO_2 emissions per unit of the relevant energy carrier are used. These are given for 2021 in table 7.

Table 7: Emission factors of energy carriers in 2021.

Energy carrier	Unit	CO_2 kg per unit
Electricity	kWh	0.475 kg/kWh or in accordance with CBS of the relevant year. NB: the power label cannot be used for this.
Natural gas	Nm^3	1.884 kg/m^3
Heat	GJ	35.97 kg/GJ
Cold	GJ	22.93 kg/GJ
Hydrogen (gas)	Nm^3	0.65 kg/m^3
Biomass (solid) unknown	kg ds	0.556 kg/kg
Wood chips	kg ds	0.062 kg/kg
Shreds	kg ds	0.054 kg/kg
Pellets dry wood	kg ds	0.035 kg/kg
Pellets fresh wood	kg ds	0.556 kg/kg
Wood logs	kg ds	0.077 kg/kg

De uitgebreide bepaling van de CO_2-emissie is dan volgens de formule:

$$WCii = \frac{\sum_{ci} C_{in;ci} - \sum_{ci} C_{out;ci} - \sum C_{excl.} + \sum_{efun} C_{cor}}{A_g} \quad [kWh/m^2 \cdot year]$$

Equation 8

waarin:

$WCii$	WEii indicator for CO_2 emissions	$[kg/m^2 \cdot year]$
$C_{in;ci}$	Annual CO_2 emissions for supplied energy carrier ci.	[kg/year]
$C_{out;ci}$	CO_2 emissions from energy carrier supplied back ci.	[kg/year]
$C_{excl.}$	Corrections related to normalizing energy use for energy function	[kg/year]
C_{efun}	The CO_2 emission for a specific energy function, such as heating	[kg/year]
C_{cor}	Corrections related to normalizing energy use for energy function efun	[kg/year]
A_g	Usable area	$[m^2]$

Appendix 1

Reference weather station selection

The reference climate station is the nearest weather station selected from the weather stations in Table 8.

Table 8: Reference weather stations

Station	Code	Latitude [degrees]	Longitude [degrees]
215	Voorschoten	52.141	4.437
235	De Kooy	52.928	4.781
240	Schiphol	52.318	4.79
249	Berkhout	52.644	4.979
251	Horn (Terschelling)	53.392	5.346
257	Wijk aan Zee	52.506	4.603
260	De Bilt	52.1	5.18
267	Stavoren	52.898	5.384
269	Lelystad	52.458	5.52
270	Leeuwarden	53.224	5.752
273	Marknesse	52.703	5.888
275	Deelen	52.056	5.873
277	Lauwersoog	53.413	6.2
278	Heino	52.435	6.259
279	Hoogeveen	52.75	6.574
280	Eelde	53.125	6.585
283	Hupsel	52.069	6.657
286	New Beerta	53.196	7.15
290	Twenthe	52.274	6.891
310	Vlissingen	51.442	3.596
319	Westdorpe	51.226	3.861
323	Wilhelminadorp	51.527	3.884
330	Hoek van Holland	51.992	4.122
344	Rotterdam	51.962	4.447
348	Cabauw	51.97	4.926
350	Gilze-Rijen	51.566	4.936
356	Herwijnen	51.859	5.146
370	Eindhoven	51.451	5.377
375	Volkel	51.659	5.707
377	Ell	51.198	5.763
380	Maastricht	50.906	5.762
391	Arcen	51.498	6.197

The distance between the weather station and the location of the building can be determined with the following formula:

D= 6371*acos(sin(lat1)*sin(lat2)+ cos(lat1)*cos(lat2)*cos(lon2-lon1)) [km]

in which:

lat1 =	latitude weather station	[degrees]
lon1 =	longitude weather station	[degrees]
lat2 =	latitude building	[degrees]
lon2 =	longitude building	[degrees]

Appendix 2

Normalising constants weather

Every year, the WEii management organisation determines the normalising constants for the various energy functions per reference weather station. This Appendix describes how these normalising constants are determined.

Heating

The normalising constant for heating is based on a degree day calculation with a heating temperature ($T_{heating}$) of 14 °C.

The sum of the degree days for a specific year is determined according to the following rules:

1. Determine the number of degree days for each day of the year:
2. 1) Determine $T_{heating} - T_{day}$ (T_{day} is average daily temperature)
   2) If the result of (1) < 0, the result is 0.
3. Add up the degree days per day over the entire year.

Determine the normalising constant for heating for a specific year for a specific weather station as follows:

$$f_{cor} = \frac{GD_{reference}}{GD_{year;weather\ station}} - 1 \qquad [-]$$

Equation 9

in which:

f_{cor}	Normalising constant for heating	[-]
$GD_{reference}$	Degree days heating based on the reference climate data.	[GD]
$GD_{year;weatherstation}$	Degree days heating based on measurements in year at weather station over the entire year.	[-]

$GD_{reference}$ 1650 GD.

Table 9: Normalising constants heating for a number of years and weather stations.

Meteo station	2014	2015	2016	2017	2018	2019	2020	2021
215		0.080	-0.022	0.050	-0.010	0.053	0.170	-0.033
235	0.272	0.124	0.025	0.093	0.016	0.120	0.215	0.001
240	0.247	0.089	-0.021	0.056	0.021	0.083	0.199	-0.032
249	0.166	0.024	-0.084	-0.027	-0.046	0.024	0.111	-0.092
251	0.151	0.042	-0.046	0.012	-0.069	0.028	0.080	-0.098
257	0.321	0.139	0.021	0.105	0.030	0.142	0.253	0.006
260	0.203	0.046	-0.068	0.008	-0.024	0.033	0.141	-0.069
267	0.176	0.038	-0.073	0.001	-0.060	0.024	0.113	-0.078
269	0.155	0.002	-0.103	-0.016	-0.029	0.014	0.117	-0.084
270	0.103	-0.021	-0.118	-0.050	-0.078	-0.016	0.050	-0.122
273	0.149	0.013	-0.113	-0.034	-0.062	-0.025	0.078	-0.107
275	0.088	-0.061	-0.146	-0.086	-0.082	-0.044	0.043	-0.146
277	0.170	0.076	-0.048	0.026	-0.035	0.062	0.140	-0.473
278	0.108	-0.040	-0.149	-0.074	-0.091	-0.039	0.040	-0.131
279	0.071	-0.068	-0.154	-0.089	-0.113	-0.071	0.003	-0.149
280	0.053	-0.061	-0.161	-0.105	-0.117	-0.063	-0.001	-0.163
283	0.091	-0.051	-0.147	-0.075	-0.085	-0.051	0.028	-0.146
286	0.022	-0.071	-0.171	-0.109	-0.123	-0.077	0.004	-0.166
290	0.093	-0.048	-0.157	-0.088	-0.096	-0.051	0.035	-0.151
310	0.476	0.258	0.145	0.200	0.130	0.257	0.399	0.094
319	0.272	0.097	-0.001	0.072	0.031	0.092	0.242	0.005
323					0.076	0.129	0.297	0.043
330	0.399	0.205	0.089	0.182	0.079	0.181	0.315	0.079
344	0.276	0.110	-0.002	0.071	0.032	0.093	0.224	-0.003
348	0.184	0.022	-0.071	0.001	-0.012	0.035	0.136	-0.078
350	0.192	0.038	-0.062	0.009	-0.016	0.042	0.169	-0.067
356	0.156	0.007	-0.082	-0.025	-0.036	0.006	0.118	-0.108
370	0.185	0.029	-0.062	-0.005	-0.018	0.038	0.143	-0.085
375	0.145	0.002	-0.086	-0.023	-0.045	0.004	0.121	-0.096
377	0.184	0.018	-0.079	-0.025	-0.044	-0.007	0.117	-0.095
380	0.199	0.027	-0.070	-0.007	-0.011	0.029	0.153	-0.076
391	0.187	0.019	-0.071	-0.008	-0.023	0.010	0.132	-0.102

Local photovoltaic generation

The normalising constant for local generation with photovoltaic cells is based on total global solar radiation.

Determine the sum of the global solar radiation per hour over the whole year:

$$G = \sum_{hour\ i=1:8760} G_{hour} \qquad [-] \qquad \text{Equation 10}$$

in which:

$G_{hour=i}$	average global solar radiation in the hour in question	[W/m²]
G	global solar radiation summed up over the year	[Wh/year]

Determine the normalising constant for local solar generation for a specific year for a specific weather station as follows:

$$f_{cor} = \frac{G_{reference}}{G_{year;weather\ station}} - 1 \qquad [-] \qquad \text{Equation 11}$$

in which:

f_{cor}	normalisation constant for local solar generation	[-]
$G_{reference}$	Solar radiation based on the reference climate data (1066000Wh)	[Wh/year]
$G_{year;weatherstation}$	Solar radiation based on measurements in year at weather station over the entire year.	[Wh/year]

Table 10: Normalising constants local solar generation for several years and weather stations.

Meteo station	2014	2015	2016	2017	2018	2019	2020	2021
215		-0.041	-0.044	-0.047	-0.097	-0.040	-0.084	-0.028
235	-0.046	-0.048	-0.068	-0.039	-0.083	-0.082	-0.103	-0.018
240	-0.004	-0.037	-0.011	0.012	-0.076	-0.038	-0.066	0.018
249	-0.004	-0.020	-0.030	-0.014	-0.082	-0.040	-0.066	-0.008
251	-0.033	-0.030	-0.062	-0.027	-0.078	-0.038	-0.067	-0.007
257	-0.022	-0.044	-0.041	-0.027	-0.075	-0.057	-0.086	-0.021
260	0.024	-0.007	0.026	0.045	-0.063	-0.030	-0.053	0.033
267	-0.033	-0.036	-0.046	-0.014	-0.080	-0.059	-0.081	-0.037
269	0.017	0.011	0.022	0.001	-0.077	-0.044	-0.078	-0.001
270	0.002	0.014	-0.007	0.024	-0.058	-0.024	-0.058	0.035
273	0.020	-0.005	-0.009	0.018	-0.081	-0.035	-0.050	0.032
275	0.064	0.014	0.042	0.084	-0.070	-0.016	-0.020	0.038
277	-0.013	0.011	0.020	0.018	-0.044	0.008	-0.065	-0.488
278	0.032	0.013	0.017	0.041	-0.084	-0.019	-0.039	0.023
279	0.044	0.016	0.012	0.042	-0.084	-0.025	-0.029	0.035
280	0.035	0.045	0.039	0.072	-0.043	0.017	-0.008	0.045
283	0.017	-0.005	0.015	0.043	-0.103	-0.037	-0.048	0.002
286	0.002	0.017	0.017	0.058	-0.071	0.012	-0.037	0.029
290	0.045	0.011	0.029	0.067	-0.087	-0.031	-0.026	0.032
310	-0.040	-0.077	-0.082	-0.065	-0.112	-0.089	-0.130	-0.065
319	-0.009	-0.039	-0.003	-0.010	-0.083	-0.041	-0.092	-0.010
323					-0.102	-0.067	-0.112	-0.043
330	-0.034	-0.052	-0.056	-0.055	-0.090	-0.068	-0.109	-0.052
344	0.000	-0.030	-0.031	-0.008	-0.078	-0.035	-0.069	0.024
348	-0.017	-0.034	-0.020	-0.010	-0.098	-0.043	-0.077	-0.015
350	0.009	-0.040	0.003	0.006	-0.089	-0.035	-0.069	-0.007
356	-0.015	-0.034	-0.009	0.000	-0.097	-0.052	-0.097	-0.006
370	0.009	-0.036	-0.015	-0.003	-0.098	-0.046	-0.086	0.000
375	0.022	-0.014	-0.012	0.009	-0.104	-0.043	-0.083	-0.019
377	-0.028	-0.034	0.028	-0.005	-0.096	-0.059	-0.088	-0.038
380	0.005	-0.031	0.036	0.002	-0.108	-0.065	-0.093	-0.011
391	0.030	-0.008	0.001	0.030	-0.091	-0.006	-0.039	0.019

Appendix 3

WEii protocol changes

All versions of the WEii protocol and the changes between them are published on WEii.nl.

Table 11: WEii protocol version control

Version	Date	Main changes
1.0	November 2020	
1.1	March 2021	Textual changes, addition of indicator CO_2 emissions, addition of normalization factors for 2020
2.0	January 2022	Textual changes, adjustment of heat rating, addition of gas consumption indicator, adjustment of CO_2 emission indicator, addition of normalization factors for 2021

A TVVL and DGBC initiative

Dutch
Green Building
Council