**Unofficial translation.**

**Legally binding only in Finnish and Swedish**

# Decree of the Ministry of the Environment

## on the Indoor Climate and Ventilation of New Buildings

By decision of the Ministry of the Environment, the following is enacted by virtue of section 117c, subsection 3; section 117d, subsection 2; section 117f, subsection 3; section 117g, subsection 4; section 117i, subsection 4 and section 150f, subsection 4 of the Land Use and Building Act (132/1999), as amended by section 117c, subsection 3; section 117d, subsection 2; section 117f, subsection 3 and section 117i, subsection 4 of Act 958/2012; section 117g, subsection 4 of Act 1151/2016; and section 150f, subsection 4 of Act 41/2014:

Chapter 1

**General**

Section 1

*Scope of application*

This Decree applies to the design and construction of the indoor climate and ventilation of new buildings. The Decree also applies to extensions of buildings and increases of gross floor area.

The Decree does not, however, apply to the design and construction of agricultural production buildings or such new residential buildings that are intended for occupancy for a period of less than four months a year.

Section 2

*Definitions*

For the purposes of this Decree:

1) *room temperature* means air temperature in the occupied zone;

2) *ventilation* means maintaining and improving indoor air quality by changing the air of a room;

3) *specific fan power of ventilation system* (kW/(m$^3$/s)) means the combined amount of electrical power taken from the power supply by all of the fans and any connected frequency converters and other power control equipment in a building's entire ventilation system, divided by the exhaust air flow rate or outdoor air flow rate of the design operating time of the ventilation system, whichever of these is greater;

4) *air conditioning* means the control of indoor air purity, temperature, humidity and velocity by treating supply air or secondary air;

5) *secondary air* means air that is returned only to the same room or dwelling;

6) *mechanical extract ventilation system* means a system by which air is mechanically extracted from a building with a fan and replaced by outdoor air via externally mounted air transfer devices;

7) *mechanical supply and extract ventilation system* means a system by which air is mechanically extracted from a building with a fan and replaced by outdoor air supplied by means of a fan;

8) *occupiable space* means a room intended for residence or work that is intended for continuous occupancy exceeding 30 minutes;

9) *occupied zone* means the part of a room where the requirements concerning indoor climate are designed to be implemented and the lower boundary of which is the floor, the

Directive 2015/1535/EU of the European Parliament and of the Council (32015L1535); OJ L 241, 17.9.2015, p. 1
Directive 2010/31/EU of the European Parliament and of the Council (32010L0031); OJ L 153, 18.6.2010, p. 13

upper boundary of which is at the height of 1.8 metres from the floor and the vertical boundaries of which are at a distance of 0.6 metres from an exterior or interior wall or a corresponding fixed element of the building;

10) *natural ventilation system* means a system the functioning of which is based on pressure differences caused mainly by differences in height and temperature and the action of the wind in a manner whereby indoor air flows out of the building and is replaced by outdoor air via externally mounted air transfer devices;

11) *recirculation air* means air which is returned as supply air or as part of supply air in a manner whereby the recirculation air contains extract air from two or more rooms;

12) *extract air* means air that is conducted out of a room;

13) *transfer air* means air that is conducted from one space to another;

14) *design life* means the service life requirement set for a ventilation system, its part or component that is determined by the party engaging in the building project, the contractee or the designer;

15) *indoor climate* means the synthesis of the chemical, physical and microbiological conditions prevailing in a building;

16) *design occupancy period* means the period of time during which a building or space is occupied and the building or space is used in accordance with its designed intended use;

17) *supply air* means air that is conducted into a room;

18) *outdoor air* means air that is conducted in a controlled manner via ventilation from outdoors to indoor spaces;

19) *exhaust air* means extract air that is conducted out of a building.

## Chapter 2

## **Indoor climate of buildings**

### Section 3

### *Design of indoor climate*

When designing a building, a principal designer, special designer and building designer shall, in accordance with their respective duties, take into account the following factors affecting the indoor climate of the building:

1) internal load factors, such as: thermal and moisture loads, equipment, lighting, human loads, noise sources, processes, construction product emissions and other impurities related to the building's use;

2) external load factors, such as: weather and acoustic conditions, outdoor air quality and other environmental factors;

3) the location of the building and the building site.

A principal designer, special designer and building designer shall, in accordance with their respective duties, take into account the indoor climate in line with the building's intended use when:

1) designing the building's thermal insulation and vapour barriers and the properties and solar protection of windows;

2) designing the building's energy performance;

3) determining the airtightness of a building envelope, base floor and shafts and the airtightness of structures between spaces;

4) designing a building's soundproofing and noise control;

5) designing the lighting of spaces and utilisation of daylight;

6) selecting construction materials;

7) designing a building's heating and cooling as well as other building services systems, their reliability in operation and space requirements;

8) planning moisture control at the building site;

9) designing the control of cleanliness of the building work and the ventilation system;

10) drawing up the timetables for the building site, acceptance and commissioning;

11) designing the usability, appropriate use and maintenance of a building and technical systems and drawing up usage and maintenance instructions for the building.

In order to create an indoor climate which is in accordance with the building's intended use, structural means may be used, internal load factors reduced, the impact of external and internal load factors limited, and heating, cooling, ventilation and air conditioning technology means and related control and regulation employed.

## Section 4

### *Design values for room temperature*

During the design period of occupancy, a building's room temperature shall be comfortable and not adversely affected by air velocity, thermal radiation, temperature fluctuation, temperature differences or surface temperatures.

A temperature of 21 °C shall be used as the design value for room temperature during the heating season. In designs for room temperature control, room temperature may fluctuate between 20 °C and 25 °C during the heating season and between 20 °C and 27 °C outside the heating season. For a special reason, such as an activity in a space requiring specific temperatures or the special nature of a space, temperatures deviating from these values may be used as design values for room temperature and in designs for room temperature control.

The design weather data used as a basis for room temperature control design shall be the test reference year weather data provided for the various climatic zones and the design outdoor air temperatures for the heating season provided for the various climatic zones presented in Annex 1.

## Section 5

### *Indoor air quality*

Particulate impurities or physical, chemical or microbiological factors in quantities which could endanger health or odours continuously adversely affecting comfort shall not be present in indoor air.

The design value for the instantaneous concentration of carbon dioxide in indoor air during the design occupancy period of a room shall be at most 1,450 mg/m3 (800 ppm) greater than the concentration in outdoor air.

## Section 6

### *Indoor air humidity*

Indoor air humidity shall remain within values that are in accordance with the designed intended use of the spaces, so as to avoid moisture damage, microbial growth or health hazards caused by indoor air humidity.

## Section 7

### *Lighting conditions*

In a building's indoor spaces, it shall be possible to maintain the lighting required for visual tasks during the design occupancy period of the spaces.

The grouping and control of lighting shall be designed so that lighting can be controlled in accordance with activities.

Chapter 3

## Ventilation and ventilation systems

Section 8

*Ventilation*

Ventilation shall provide healthy, safe and comfortable indoor air quality in occupiable spaces. The ventilation system shall produce an adequate outdoor air flow to the building and extract from indoor air substances that are harmful to health, excessive humidity, odours with adverse effects on comfort and indoor air impurities arising from humans, construction products and activities.

The ventilation system shall be designed so that:

1) the functions central to the functioning of the selected ventilation system can be measured, controlled and monitored;

2) when correctly used, serviced and maintained, the system will remain in good working order for its design life;

3) the functioning of the system can be brought to a complete stop. In a mechanical system, there shall be a clearly labelled stop switch, which shall be located in an easily accessible place. In a natural ventilation system, the ventilation valves shall be easy to close.

Section 9

*Outdoor air flows*

A special designer shall design the ventilation system so that an outdoor air flow required for healthy, safe and comfortable indoor air quality can be delivered to the occupiable spaces. The outdoor air flow to the occupiable spaces shall be designed to be a minimum of 6 $dm^3/s$ per person during the design occupancy period where there is no need for additional air flow arising from the intended use of the space. The outdoor air flow of the entire building, however, shall be designed to be a minimum of 0.35 $(dm^3/s)/m^2$ of floor surface area during the design occupancy period where there is no need for additional air flow arising from the special nature of the intended use of a space in the building. The outdoor air flow of a dwelling unit, however, shall be designed to be a minimum of 18 $dm^3/s$.

Section 10

*Control of air flows*

It shall be possible to control air flows in accordance with load or air quality according to the occupancy situation.

The control of air flows in a dwelling unit shall be designed in a manner whereby supply and extract air flows can be controlled either at building or dwelling unit level so that they can be increased to a level at least 30% above the air flows of the design occupancy period. If ventilation can be controlled at dwelling unit level, the dwelling unit’s supply and extract air flows may be reduced by no more than 60% from the air flows of the design occupancy period.

The outdoor air flow for a building other than a residential building shall be a minimum of 0.15 $(dm^3/s)/m^2$ of floor surface area outside the design occupancy period and the air shall be exchanged in all rooms.

This section does not apply to such an extension of a building or increase of gross floor area where the existing ventilation system can be used to provide ventilation and the quality of indoor air in the building is not impaired.

Section 11

*Air flows in parking garages for motor vehicles*

A special designer shall design the ventilation air flows of a parking garage for motor vehicles so that air impurities do not cause health hazards for users. The air flows shall be designed so that the average carbon monoxide concentration in a parking garage for motor vehicles during the hour of use assessed as the most critical does not exceed 35 $mg/m^3$ (30 ppm). Air flows in the continuous working area of a parking garage for motor vehicles shall be designed so that the instantaneous carbon monoxide concentration does not exceed 7 $mg/m^3$ (6 ppm).

Section 12

*Air filtration*

A special designer shall design the level of air filtration on the basis of the outdoor air quality and the objectives set for indoor air quality. When selecting a ventilation system, the special designer shall take into account the system's suitability for the required level of filtration.

Section 13

*Extract air categories*

Extract air categories are as follows:
Category 1: extract air with only a low level of impurities and with the main sources of impurities being humans and structures;
Category 2: extract air with a moderate level of impurities;
Category 3: extract air with impurities, humidity, chemicals or odours which substantially reduce the quality of the extract air;
Category 4: extract air with a significant level of malodorous or unhealthy impurities or chemicals.

Section 14

*Installation location of externally mounted air transfer devices and exhaust air devices*

Outdoor air shall not be introduced via a structure or a structural component which impairs air quality or from the vicinity of sources of outdoor air pollutants.

Snow or rainwater shall not be allowed to ingress the ventilation system via externally mounted air transfer devices in quantities causing damage to the system, lowering air quality or impairing the functioning of the system.

The conducting of exhaust air out of a building shall be designed so that no health or other hazards are caused to the building or to other buildings, the environment or their users. Exhaust air shall be conducted to above the building's roof, unless otherwise required by the functioning of the ventilation system. Extract air of category 1 or dwelling unit ventilation exhaust air may also be conducted to the outdoors via an exhaust air device mounted on the wall of the building (*wall exhaust*), provided that the requirements laid down otherwise in this subsection are met.

Section 15

*Recirculation, transfer and secondary air*

A special designer shall design the ventilation of a building so that only air from spaces with equivalent or higher air purity can be used as recirculation or transfer air and this air shall not contain quantities of impurities that impair air quality. The use of recirculation, transfer or secondary air shall not cause any harmful spread of impurities, in particular odours.

Extract air of categories 2, 3 and 4 shall not be used as recirculation air.

Recirculation air shall not be used as supply air in the following spaces:

1) dwelling units;

2) professional kitchens;

3) accommodation sections of accommodation and catering establishments and boarding schools;

4) teaching spaces of educational institutions and rest, play and group rooms of daycare centres;

5) accommodation sections of medical care, welfare and penal institutions and corresponding facilities;

6) restaurants and cafés;

7) other spaces to be kept particularly clean, unless the recirculation air is purified to the level required by the intended use of the space.

Section 16

*Spreading of impurities in heat recovery units*

If a ventilation system is equipped with heat recovery, a special designer shall design heat recovery so as to avoid the spreading of impurities or odours causing adverse effects to health or comfort via the process. When heat is recovered from extract air of category 4, there shall be no leaks between supply and extract air. When heat is recovered from extract air of other extract air categories, the direction of the leakage air flow shall be primarily from the supply air side towards the extract air side.

In heat recovery of a ventilation system that serves a single space or a single dwelling unit, the direction of leakage air flow may, in all extract air categories, also be from the extract air side towards the supply air side if the supply air is sufficient to guarantee compliance with the requirements set for indoor air quality in section 5 and for indoor air humidity in section 6 and the volume of outdoor air flow fulfils the requirements in accordance with section 9.

Section 17

*Distribution and extraction of air*

The distribution and extraction of air in a building shall be such that air flows to the entire occupied zone while avoiding air velocity causing discomfort, with the exception of any need for enhanced ventilation, and that impurities generated in a room are efficiently extracted. The air in a building shall flow from spaces of higher indoor air purity to spaces of lower indoor air purity.

Section 18

*Combining ventilation*

Combining of ventilation ducts must not give rise to a risk of impurities spreading or impair the functioning of the ventilation system.

Ventilation ducts may be combined on the basis of extract air categories as follows:

1) extract air of categories 1 and 2 may be conducted into common ductwork. If the air flows of extract air categories 1 and 2 are combined into the same duct and category 2 air flow accounts for more than 10% of the combined air flow, the combined air flow is classified under category 2;

2) extract air of category 3 shall be conducted through individual ducts, or common ducts serving spaces of the same type as regards level of air purity, to the outdoors, into a collection duct installed above the spaces it serves or into an extract air chamber. Extract air from toilets, washrooms and cleaning spaces may be conducted to vertical ducts for extract air categories 1 and 2 if the total extract air flow from these spaces does not exceed 10% of the total air flow in the vertical duct. In such cases, the combined air flow shall not be used as recirculation air. In mechanical ventilation, extract air from all of the spaces of a single dwelling unit may be conducted through the same air duct directly to the outdoors, into a collection duct installed above the spaces it serves or into an extract air chamber. Extract air from different dwelling units may be conducted to common vertical ducts of the same mechanical ventilation system in such a way that extract air from the kitchens is conducted to a vertical duct that serves the kitchens, while extract air from other spaces is conducted to an individual vertical duct. In natural ventilation, the vertical ducts of a single dwelling may not be combined, nor may common vertical ducts of more than one dwelling be used;

3) extract air of category 4 shall be conducted to the outdoors through individual extract air ducts. If significant quantities of substances that are hazardous to health or that generate a strong odour are handled or stored in a space, outdoor air and extract air ducts that are separate from the rest of the ventilation system shall be provided for that room and the space shall be designed to be at negative pressure in relation to adjacent spaces.

Any connection of two or more air handling units to the same duct or chamber shall be designed so that the pressures of the rooms or the directions of air flow between the rooms and in the ductworks do not change when the air flows of the units are being controlled. A natural ventilation system, a mechanical extract ventilation system or a mechanical supply and extract ventilation system shall not be designed to be combined in such a way that the directions of air flow between the rooms and in the ductworks may change when the air flows are being controlled.

## Section 19

### *Ventilation airtightness classes*

The maximum permissible leakage air flow rates for ventilation systems, air ducts and parts of ducts per casing surface area $q_{VIA}$ ($dm^3/s/m^2$) at test pressure $p_s$ (Pa) for the various airtightness classes are as follows:

| Airtightness class | Maximum permissible leakage air flow $q_{VIA}$ $dm^3/s/m^2$ |
|---|---|
| A | $0.027 \times p_s^{0.65}$ |
| B | $0.009 \times p_s^{0.65}$ |
| C | $0.003 \times p_s^{0.65}$ |
| D | $0.001 \times p_s^{0.65}$ |
| E | $0.0003 \times p_s^{0.65}$ |

## *Section 20*

### *Requirements for ventilation system airtightness and strength*

The natural or mechanical ventilation system of a building shall be strong and its airtightness shall be at least class B. If the extract air contains significant amounts of impurities other than of human origin, the airtightness class shall be at least C.

In a mechanical ventilation system, the extract air ducts within the building that are located outside the plant room shall be designed to be at negative pressure. Extract air ducts in extract air categories 1 and 2 may, however, be at positive pressure within the building, provided that the ductwork is at least of airtightness class C. Extract air ducts in extract air category 3 and exhaust air ducts for individual dwelling units may be at positive pressure within the building, provided that the ductwork is at least of airtightness class D. Extract air ducts in extract air category 4 may be at positive pressure within the building if the ductwork does not leak.

In natural and mechanical ventilation systems, the stiffening and support of air ducts shall be designed so that the ducts remain firmly in place and can withstand any pressure fluctuations, cleaning and other stresses that may occur in the ventilation system.

In a mechanical ventilation system, the air handling units and chambers shall be able to withstand the loads caused by fan pressure while the shut-off dampers are closed. If the cross-sectional area of a mechanical ventilation system's air duct is designed to be greater than 0.06 $m^2$, the outdoor air and exhaust air ducts shall be fitted with shut-off dampers that close automatically when the system shuts down.

Section 21

*Pressures caused by air flows and airtightness of structures*

A special designer shall design a building's outdoor air and exhaust air flows so that structures are not exposed to any long-term moisture loads damaging the structures due to positive pressure or any transfer of impurities to indoor air due to negative pressure. A principal designer, special designer and building designer shall, in accordance with their respective duties, design the airtightness of a building's envelope and internal structures and its chimney effect management so that the prerequisite conditions for the functioning of ventilation can be secured, the transfer to indoor air of impurities from structures, soil impurities and radon is avoided and the transfer of moisture into structures is avoided.

Section 22

*Fuel-fired appliances and separate extract systems*

A special designer shall design the supply of additional outdoor air flow required by the use of any fuel-fired appliance and separate extract systems so that the building's ventilation system functions in a controlled manner and there are no detrimental changes in pressures in the building or rooms.

Section 23

*Air humidification*

If the ventilation system is equipped with air humidification, a special designer shall design the air humidification so as to avoid the conditions for microbial growth that is hazardous to health.

Section 24

*Ventilation system cleanability and serviceability*

A special designer shall design the ventilation system and its maintenance and servicing access routes so that the parts of the ventilation system can be easily and safely cleaned, serviced, repaired and replaced. For the maintenance, servicing and repair of air handling units, space which is at least the size of the units to be maintained or serviced shall be reserved in the access direction.

Section 25

*Ventilation system insulation*

A special designer shall design the thermal insulation and vapour barriers of ventilation ducts, chambers and air handling units so that air will not cool down or warm up in a way that causes adverse effects on temperature control or comfort and so that there will not be any condensation of moisture damaging structures or reducing indoor air quality.

Chapter 4

## Ventilation system commissioning measurements

Section 26

*Airtightness*

The party engaging in the building project shall see to the measurement of the airtightness of the ventilation system prior to the commissioning of a building. As regards ventilation systems serving a single space in a building or a single dwelling unit, the airtightness measurement may be replaced by an installation survey if the ductwork consists entirely of ducts and duct components at least of airtightness class C. The person responsible for the construction stage shall make an entry in the building inspection documents concerning compliance of the airtightness of the ventilation system with design specifications.

Section 27

*Verification of ventilation system compliance with design specifications*

The party engaging in the building project shall see to the measurement and adjustment of the air flows of the ventilation system, the determination of the system's specific fan power and the compliance of the functioning of the ventilation system with design specifications prior to the commissioning of a building.  The building and its ventilation system shall be clean before air flow measurement and adjustment and before system commissioning. The person responsible for the construction stage shall make an entry in the building inspection documents concerning compliance of the ventilation system with design specifications.

Permissible tolerances in respect of design values may be as follows:

1) air flow at system and dwelling unit level ± 10%;

2) air flow at room level ± 20%, with, however, the deviation always permitted to be at least 1 dm3/s;

3) specific fan power of ventilation system + 10%.

The permissible tolerances include both measurement result deviations and the measurement uncertainty, which shall be stated in conjunction with measurement results. The measurement method and measuring instruments shall suitable for measuring the air flow to be measured. The measuring instruments shall be calibrated, the calibration shall be currently valid, and the measurement value shall be corrected in accordance with the calibration.

Chapter 5

## Transitional provisions and entry into force

Section 28

*Entry into force*

This Decree enters into force on 1 January 2018.

This Decree repeals the Decree of the Ministry of the Environment on the Indoor Climate and Ventilation of Buildings of 30 March 2011.

Upon the entry into force of this Decree, pending projects shall be subject to the rules valid at the time of entry into force of this Decree.

Helsinki, 20 December 2017

Kimmo Tiilikainen, Minister for Housing, Energy and the Environment

Pekka Kalliomäki, Senior Construction Adviser

Weather data used in the design of room temperature control

The weather data provided in Tables L1.1–L1.4 is used in the design of room temperature control. Finland is divided into four climatic zones, which are presented in Figure L1.1. Hourly weather data is available from the Ministry of the Environment website.

For climatic zones I and II, the same weather data but separate design outdoor air temperatures are used.

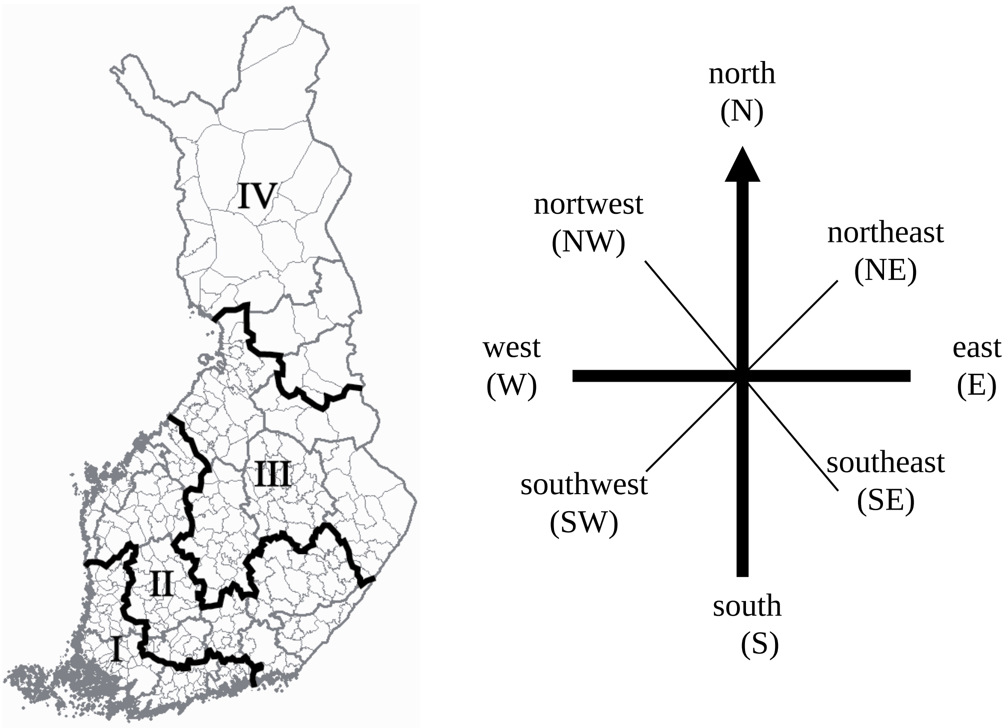


Figure L1.1. Climatic zones and compass point abbreviations.

| *Table L1.1.* | *Design outdoor air temperatures for the various climatic zones.* |
|---|---|
| Climatic zone | Design outdoor air temperature, °C |
| E | -26 |
| II | -29 |
| III | -32 |
| IV | -38 |

*Table L1.2. Monthly weather data for climatic zones I and II. Helsinki-Vantaa.*

| Month | Average outdoor air temperature, $T_o$, °C | Gross solar radiation energy on horizontal plane, $G_{radiation, horizontal plane}$, kWh/m² |
|---|---|---|
| January | -3.97 | 6.2 |
| February | -4.50 | 22.4 |
| March | -2.58 | 64.3 |
| April | 4.50 | 119.9 |
| May | 10.76 | 165.5 |
| June | 14.23 | 168.6 |
| July | 17.30 | 180.9 |
| August | 16.05 | 126.7 |
| September | 10.53 | 82.0 |
| October | 6.20 | 26.2 |
| November | 0.50 | 8.1 |
| December | -2.19 | 4.4 |
| Entire year | 5.57 | 975 |

| | Gross solar radiation energy on vertical planes for each compass point, $G_{radiation, vertical plane}$, kWh/m² | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | N | NE | E | SE | S | SW | W | NW |
| January | 6.2 | 4.7 | 3.8 | 9.5 | 12.9 | 9.5 | 3.8 | 4.7 |
| February | 17.3 | 13.8 | 15.6 | 31.0 | 41.4 | 30.9 | 15.6 | 14.0 |
| March | 40.3 | 38.1 | 48.5 | 75.1 | 89.5 | 69.4 | 43.7 | 36.9 |
| April | 43.9 | 56.3 | 79.9 | 101.1 | 107.3 | 101.6 | 80.6 | 56.8 |
| May | 57.8 | 82.1 | 112.8 | 123.3 | 116.0 | 117.5 | 104.5 | 76.3 |
| June | 70.6 | 87.9 | 109.6 | 109.9 | 101.6 | 110.9 | 111.2 | 89.1 |
| July | 66.3 | 91.1 | 118.8 | 123.1 | 115.5 | 128.6 | 122.7 | 91.2 |
| August | 50.0 | 66.4 | 91.8 | 106.0 | 100.4 | 92.8 | 78.8 | 61.1 |
| September | 32.9 | 37.5 | 56.5 | 83.9 | 100.5 | 87.3 | 59.3 | 38.1 |
| October | 17.9 | 15.6 | 17.5 | 28.3 | 37.0 | 30.0 | 18.8 | 15.7 |
| November | 7.2 | 5.5 | 5.1 | 12.3 | 16.8 | 12.3 | 5.1 | 5.6 |
| December | 4.2 | 3.2 | 2.6 | 8.4 | 11.8 | 8.8 | 2.9 | 3.2 |
| Entire year | 414.6 | 502.2 | 662.5 | 811.9 | 850.7 | 799.6 | 647.0 | 492.7 |

| Month | Conversion factor $F_{direction}$ for converting gross solar radiation energy on horizontal plane to gross solar radiation energy on vertical plane for each compass direction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | N | NE | E | SE | S | SW | W | NW |
| January | 0.995 | 0.757 | 0.609 | 1.531 | 2.080 | 1.519 | 0.605 | 0.759 |
| February | 0.774 | 0.618 | 0.700 | 1.387 | 1.854 | 1.381 | 0.700 | 0.624 |
| March | 0.627 | 0.592 | 0.754 | 1.169 | 1.392 | 1.079 | 0.679 | 0.574 |
| April | 0.366 | 0.470 | 0.666 | 0.843 | 0.895 | 0.847 | 0.672 | 0.474 |
| May | 0.349 | 0.496 | 0.681 | 0.745 | 0.701 | 0.710 | 0.632 | 0.461 |
| June | 0.419 | 0.521 | 0.650 | 0.652 | 0.602 | 0.658 | 0.659 | 0.528 |
| July | 0.367 | 0.503 | 0.657 | 0.681 | 0.639 | 0.711 | 0.679 | 0.504 |
| August | 0.395 | 0.524 | 0.725 | 0.837 | 0.793 | 0.732 | 0.622 | 0.482 |
| September | 0.401 | 0.457 | 0.689 | 1.023 | 1.225 | 1.064 | 0.723 | 0.465 |
| October | 0.683 | 0.595 | 0.670 | 1.081 | 1.412 | 1.144 | 0.718 | 0.598 |
| November | 0.888 | 0.683 | 0.632 | 1.519 | 2.068 | 1.519 | 0.633 | 0.686 |
| December | 0.920 | 0.697 | 0.571 | 1.850 | 2.615 | 1.942 | 0.637 | 0.697 |
| Entire year | 0.425 | 0.515 | 0.679 | 0.833 | 0.872 | 0.820 | 0.663 | 0.505 |

*Table L1.3.* *Monthly weather data for climatic zone III. Jyväskylä.*

| Month | Average outdoor air temperature, $T_o$, °C | Gross solar radiation energy on horizontal plane, $G_{radiation, horizontal plane}$, kWh/m² |
|---|---|---|
| January | -8.00 | 5.4 |
| February | -7.10 | 20.1 |
| March | -3.53 | 51.9 |
| April | 2.42 | 102.9 |
| May | 8.84 | 171.4 |
| June | 13.39 | 159.1 |
| July | 15.76 | 158.2 |
| August | 13.76 | 113.9 |
| September | 9.18 | 71.1 |
| October | 4.07 | 25.3 |
| November | -1.76 | 7.3 |
| December | -5.92 | 3.2 |
| Entire year | 3.43 | 890 |

| | Gross solar radiation energy on vertical planes for each compass point, $G_{radiation, vertical plane}$, kWh/m² | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | N | NE | E | SE | S | SW | W | NW |
| January | 6.0 | 4.5 | 3.1 | 6.5 | 9.0 | 6.8 | 3.3 | 4.5 |
| February | 16.4 | 12.8 | 15.6 | 34.4 | 46.3 | 33.5 | 15.1 | 12.8 |
| March | 38.7 | 35.2 | 37.9 | 55.1 | 69.8 | 60.2 | 42.1 | 36.1 |
| April | 46.1 | 54.5 | 73.5 | 93.6 | 99.1 | 89.5 | 70.0 | 53.6 |
| May | 68.9 | 91.3 | 122.6 | 132.4 | 123.4 | 124.5 | 115.0 | 88.5 |
| June | 72.7 | 87.1 | 105.4 | 108.0 | 103.3 | 107.5 | 103.6 | 85.0 |
| July | 65.1 | 81.4 | 106.2 | 115.0 | 109.4 | 111.6 | 104.5 | 82.6 |
| August | 48.0 | 57.0 | 74.5 | 91.7 | 98.3 | 94.5 | 77.3 | 58.1 |
| September | 30.6 | 34.2 | 51.8 | 77.7 | 91.6 | 76.1 | 50.1 | 33.4 |
| October | 15.3 | 13.6 | 18.5 | 33.1 | 42.5 | 32.1 | 17.6 | 13.3 |
| November | 6.9 | 5.3 | 4.9 | 10.7 | 14.6 | 10.7 | 4.9 | 5.3 |
| December | 3.3 | 2.5 | 1.6 | 3.3 | 4.4 | 3.2 | 1.6 | 2.5 |
| Entire year | 418.0 | 479.4 | 615.6 | 761.5 | 811.7 | 750.2 | 605.1 | 475.7 |
| | Conversion factor $F_{direction}$ for converting gross solar radiation energy on horizontal plane to gross solar radiation energy on vertical plane for each compass direction | | | | | | | |
| Month | N | NE | E | SE | S | SW | W | NW |
| January | 1.094 | 0.833 | 0.568 | 1.189 | 1.651 | 1.256 | 0.610 | 0.824 |
| February | 0.817 | 0.636 | 0.778 | 1.712 | 2.306 | 1.670 | 0.750 | 0.639 |
| March | 0.747 | 0.678 | 0.730 | 1.063 | 1.346 | 1.160 | 0.811 | 0.696 |
| April | 0.448 | 0.530 | 0.715 | 0.910 | 0.963 | 0.870 | 0.681 | 0.521 |
| May | 0.402 | 0.533 | 0.715 | 0.773 | 0.720 | 0.726 | 0.671 | 0.517 |
| June | 0.457 | 0.547 | 0.662 | 0.679 | 0.649 | 0.675 | 0.651 | 0.534 |
| July | 0.412 | 0.514 | 0.671 | 0.727 | 0.692 | 0.705 | 0.661 | 0.522 |
| August | 0.422 | 0.500 | 0.654 | 0.805 | 0.863 | 0.830 | 0.679 | 0.510 |
| September | 0.430 | 0.481 | 0.729 | 1.093 | 1.288 | 1.071 | 0.705 | 0.470 |
| October | 0.604 | 0.535 | 0.729 | 1.305 | 1.675 | 1.268 | 0.695 | 0.523 |
| November | 0.937 | 0.717 | 0.665 | 1.459 | 1.984 | 1.458 | 0.665 | 0.719 |
| December | 1.015 | 0.762 | 0.503 | 1.006 | 1.352 | 0.997 | 0.500 | 0.765 |
| Entire year | 0.470 | 0.539 | 0.692 | 0.856 | 0.912 | 0.843 | 0.680 | 0.535 |

| *Table L1.4.* | *Monthly weather data for climatic zone IV. Sodankylä.* | |
|---|---|---|
| Month | Average outdoor air temperature, $T_o$, °C | Gross solar radiation energy on horizontal plane, $G_{radiation,\ horizontal\ plane}$, kWh/m² |
| January | -13.06 | 1.4 |
| February | -12.62 | 13.6 |
| March | -6.88 | 48.0 |
| April | -1.56 | 121.0 |
| May | 5.40 | 128.1 |
| June | 13.03 | 154.2 |
| July | 14.36 | 146.4 |
| August | 12.06 | 94.5 |
| September | 6.60 | 63.7 |
| October | 0.15 | 16.6 |
| November | -6.78 | 3.0 |
| December | -10.08 | 0.2 |
| Entire year | 0.05 | 791 |

| | Gross solar radiation energy on vertical planes for each compass point, $G_{radiation,\ vertical\ plane}$, kWh/m² | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | N | NE | E | SE | S | SW | W | NW |
| January | 1.4 | 1.1 | 0.7 | 1.1 | 1.4 | 1.1 | 0.7 | 1.1 |
| February | 13.2 | 10.2 | 9.4 | 19.8 | 27.6 | 21.0 | 10.2 | 10.1 |
| March | 38.0 | 33.2 | 36.4 | 57.9 | 74.6 | 60.6 | 38.6 | 33.5 |
| April | 59.0 | 70.8 | 100.8 | 134.9 | 146.7 | 127.8 | 93.7 | 67.9 |
| May | 63.8 | 79.8 | 97.6 | 99.5 | 91.4 | 91.1 | 85.9 | 71.7 |
| June | 78.7 | 90.5 | 106.7 | 106.3 | 101.2 | 105.9 | 106.0 | 89.9 |
| July | 69.7 | 84.0 | 104.0 | 111.2 | 107.9 | 104.2 | 94.4 | 77.4 |
| August | 44.1 | 50.7 | 62.8 | 77.0 | 84.9 | 83.4 | 68.4 | 52.1 |
| September | 25.5 | 31.0 | 51.8 | 80.2 | 92.7 | 74.5 | 46.1 | 28.7 |
| October | 12.8 | 10.2 | 11.8 | 23.8 | 31.2 | 22.8 | 11.2 | 10.4 |
| November | 3.1 | 2.4 | 1.8 | 4.0 | 5.5 | 4.2 | 1.9 | 2.4 |
| December | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 |
| Entire year | 409.5 | 464.1 | 583.9 | 715.9 | 765.3 | 696.8 | 557.2 | 445.4 |

| Month | Conversion factor $F_{direction}$ for converting gross solar radiation energy on horizontal plane to gross solar radiation energy on vertical plane for each compass direction | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | NE | E | SE | S | SW | W | NW |
| January | 1.000 | 0.750 | 0.479 | 0.764 | 1.014 | 0.764 | 0.479 | 0.750 |
| February | 0.966 | 0.749 | 0.686 | 1.451 | 2.025 | 1.540 | 0.745 | 0.744 |
| March | 0.792 | 0.691 | 0.759 | 1.205 | 1.554 | 1.262 | 0.804 | 0.698 |
| April | 0.488 | 0.585 | 0.833 | 1.115 | 1.213 | 1.056 | 0.774 | 0.561 |
| May | 0.498 | 0.623 | 0.762 | 0.777 | 0.714 | 0.711 | 0.671 | 0.560 |
| June | 0.511 | 0.587 | 0.692 | 0.689 | 0.657 | 0.687 | 0.687 | 0.583 |
| July | 0.476 | 0.574 | 0.710 | 0.759 | 0.737 | 0.712 | 0.644 | 0.528 |
| August | 0.467 | 0.536 | 0.665 | 0.814 | 0.898 | 0.883 | 0.724 | 0.551 |
| September | 0.400 | 0.487 | 0.813 | 1.259 | 1.454 | 1.169 | 0.724 | 0.451 |
| October | 0.774 | 0.618 | 0.710 | 1.435 | 1.883 | 1.375 | 0.673 | 0.625 |
| November | 1.026 | 0.780 | 0.576 | 1.299 | 1.819 | 1.375 | 0.625 | 0.776 |
| December | 0.955 | 0.727 | 0.455 | 0.727 | 0.955 | 0.727 | 0.455 | 0.727 |
| Entire year | 0.518 | 0.587 | 0.738 | 0.905 | 0.968 | 0.881 | 0.704 | 0.563 |