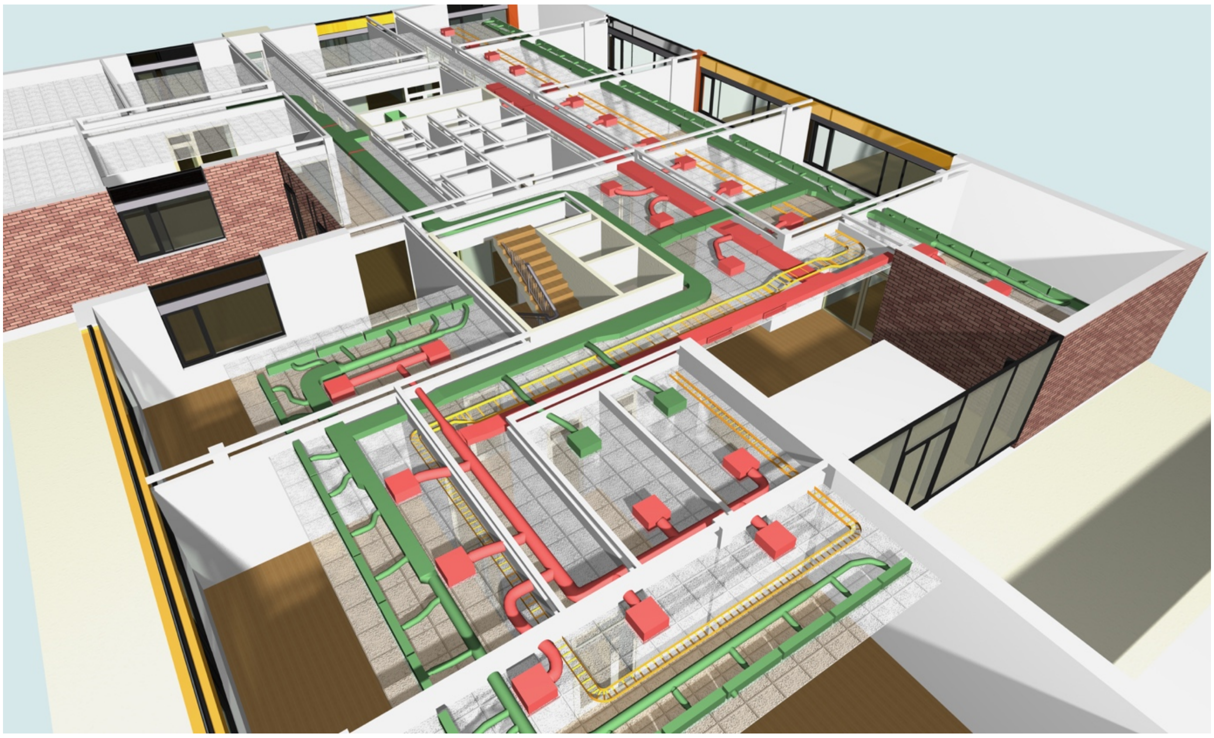
MŰEGYETEM 1782
Budapest University of Technology and Economics, Faculty of Architecture
Department of Building Energetics and Services, www.egt.bme.hu

Building Energetics and Services

COMPLEX 1 & DIPLOMA

Design Aid



Levente Filetóth

2018 January

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This design aid is based on the

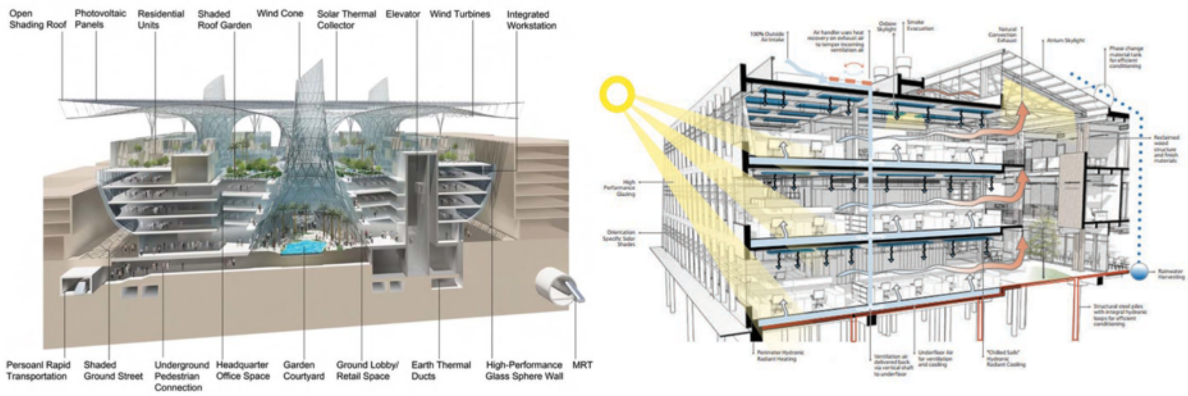
- Complex and Diploma Design Aid written by: Zsófia Bélafi, István Egri, Levente Filetóth, Lajos Gyurcsovics, Norbert Harmathy, Zoltán Magyar, Andras Majoros, Csaba Szikra, Emil Vetesi, János Viczai and Balázs Kereszty,
- Building Energetics book, ISBN 978-963-7298-31-8, Pécs, 2009.

Edited and translated by Levente Filetóth, 2018.

Building Energetics and Services Tasks

The goal of the Building Energetics and Services related Complex 1 and Diploma design task is to

- **identify** the existing and required **building utilities,**
- **determine** the used **building systems** and **services** and **assign** adequate **rooms** and **spaces** for their operation,
- **determine** the overall building **energy performance** and **identify** applicable **renewable energy systems**.



Schematic cross sections presenting building systems and energy schemes

Deliverables

Please complete and submit the following obligatory deliverables keeping the submission deadlines announced by the faculty:

1. **Building utilities and services layout** on the Site Plan at least at a 1:500 scale (recommended for the preliminary design presentation).
2. **Describe** the **building systems and services** that are necessary to operate the building, **determine** the necessary **rooms, areas and spaces** required for their operation.
3. **Determine** the **overall building energy performance** and **identify** applicable renewable energy systems. Please also **create** a draft sketch of the **energy systems and operations** of the building on a power supply concept level.

For those who wish to submit a more in-depth and extended content for Building Energetics and Services:

- Please validate that **all composite structures** on the building envelope meet the **thermal requirements** and that **the specific heat loss factor** of the building is also adequate.
- Please provide a **detailed calculation** for the overall **electric power demand** of the building.

1. Building Utilities and Services Layout

The building site utility plan should include the following details:

- Orientation, address or location of the property with the indication of the surrounding roads and buildings.
- Location of the building, driveways, parking lots with respect to the property line including main dimensions.
- Location of the existing (or planned) utilities required to operate the building using different colors and line-types: water and sanitary sewer lines, location of the gas- and electric services, central heating systems, location of fire hydrants (if applicable), etc.
- Indicate where the various utilities and services will be connected to the building.

Site plan presenting the existing and proposed public utilities and services

You may collect information about the existing utilities and services of the site by visiting the site, cheking the website of the corresponding municipalities. In case you can't find any relavant information about the existing utilities please contact your consultant to identify the probable options and locations.

Please present and discuss the available and planned utilities, services and their locations with your consultant before the submission of the preliminary design!

2. Building Services

This chapter of he design aid provides help and guidlines to briefly describe the main characteristics of all the required building services and building systems, including **heating**, **domestic hot water** production, **ventilation**, **cooling** and **lighting**. The goal is to determine the characteristics of the **required rooms and plants** necessary to provide in the building or on the building site.

2.1. Heating

The **Heating Plant or the Boiler Room** typically also incorporates the **Domestic Hot Water Plant** (see 2.2.) as well. It is recommended to create one unified room for the machinery and systems of heating and for domestic hot water plant or to locate these rooms next to each other. (*In certain case a separate plant must be provided, please refer to the* ***2.2. Domestic Hot Water Production*** *chapter of this aid for further details.)*

The following table provide estimated heating demand, **Q [kW]** for some building types and sizes. **V [m^3]** represents the total volume of the internal heated rooms and spaces. Please review the estimated values with your consultant.

Building type	Heated floor area, A [m^2]	Heating, Q [kW]
Residential	< 500	**30** kW
	500 ... 1000	**60** kW
	> 1000	**V** m^3 · **20** W/m^3
Office	< 1000	**80** kW
	1000 ... 2000	**150** kW
	> 2000	**V** m^3 · **15** W/m^3
Educational	< 1000	**80** kW
	1000 ... 2000	**150** kW
	> 2000	**V** m^3 · **20** W/m^3
Health care	< 1000	**80** kW
	1000 ... 2000	**150** kW
	> 2000	**V** m^3 · **25** W/m^3

Estimated heating demands of building types

Depending on the **overall heated floor area,** A [m^2] or **overall heated volume**, V [m^3] a boiler **room** or a **plant** must be provided and depending on the estimated performance of the heating system (Q, [kW] a **dedicated gas boiler plant** must be designed and indicated in the architectural design.

2.1.1. Boiler and Heat Pump Rooms: 500m² or less total heated floor area

If the overall, net **heated floor area** in the building is **less than 500 m²**, the area of the **boiler or pump rooms** must be:

Heating system	Room area: A [m²]
Wall-mounted boiler	**2 - 15 m²**
Heat pump	**5 - 20 m²**
Solid fuel boiler	**15 - 30 m²**

Room areas of heating systems if the total heated floor area is < 500m²

2.1.2. Heating Plant: 500m² or more total heated floor area

If the overall, net **heated floor area** in the building is **more than 500 m²**, then a dedicated **heating plant** should be allocated on the **ground floor** or on the **first basement level**. Adequate transportation and service route to the plant room must also be ensured.

The room must have a double-leaf door opening outwards. The **headroom** should be minimum **2,65 m** and the **floor area** of the **heating plant** must be:

Heating demand Q [kW]	Plant area A [m²]
Q < 450 kW	**17 m²**
450 kW < Q < 800 kW	**17 - 22 m²**
800 kW < Q < 1.630 kW	**22 - 35 m²**

Heating plant areas if the total heated floor area is > 500m²

The floor area of the heating plant can also be calculated using the following formula:

- **$A = 10 + 0{,}014 \cdot (Q / 1000)$ [m²]**
    - o Q represents the total heating demand of the building [kW]

2.1.3. Gas Meter Boxes and Cabinets

If the calculated gas demand of the building is **less than 100 m³/h,** then **Gas Meter Box**, recessed box or **Cabinet** should be created (no need to create a dedicated gas meter room). Such boxes and cabinets must have ventilation outlets and should be located in circulation areas (such as staircases).

Gas meters in residential buildings	Gas meter box and cabinet sizes
1 gas meter (or 1+1) * unit	Box width: **51 cm**, depth: **25 cm**
2 gas meters (or 2+2) * unit	Cabinet width: **102 cm**, depth: **25 cm**

*** (1+1) or (2+2) gas meter units are located under each other**

Gas meters in non-residential buildings	Gas meter cabinet sizes
Gas demand is **9 - 15 m^3/h**	Cabinet width: **80 cm**, depth: **40 cm**
Gas demand is **15 - 30 m^3/h**	Cabinet width: **100 cm**, depth: **40cm**
Gas demand is **30 - 60 m^3/h**	Cabinet width: **150 cm**, depth: **70cm**

Gas meter cabinet sizes in non-residential buildings are depending on the gas demand

AGP, MCL, Tricel

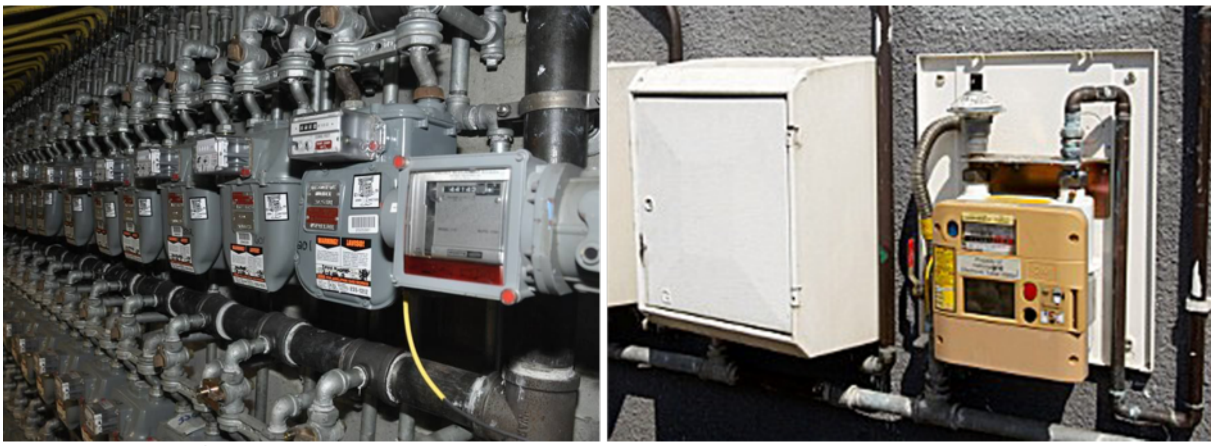
2.1.4. Gas Meter Room

If the calculated gas demand of the building is **more than 100 m^3/h,** then dedicated **Gas Meter Room(s)** must be provided.

Such room must be located on the ground floor located along the external perimeter of the building and having a double-leaf metal door opening towards the exterior. The external wall surface must also have adequate ventilation area (at least 1% of the floor area of the room) and should also equipped with adequate "**explosion pressure relief**" surface as described at the corresponding paragraph of this design aid.

Gas meters in non-residential buildings	Gas meter room dimensions
Gas demand is **75 - 150 m^3/h**	Floor area: **2,50 m^2**, headroom: **2,65 m**
Gas demand is **150 - 220 m^3/h**	Floor area: **5,00 m^2**, headroom: **3,00 m**

Gas meter room dimensions are depending on the gas demand



Gas meter room and gas meter cabinet mounted on external wall

2.1.5. Gas Boiler Plant: above 140 kW total heating power demand

If the heating power demand of the building is higher than 140 kW, a dedicated **gas boiler plant** must be provided. Adequate transportation and service route to the plant room must also be ensured. Gas boiler plants must be supervised by dedicated **personnel** who requires a **resting** area as well as a **sanitary** unit.

The **location** of the **gas boiler plant** in case of a "flammable or explosive" environment **must be located on the top or roof**, if the function of the building is:

- Residential,
- Health care,
- Institutional,
- Educational,
- Public building with large amount of people (eq. concert or conference hall).

Heating demand Q [kW]	Gas boiler plant dimensions
Q < 450 kW	Floor area: **30 m²**, headroom: **3,00 m**
450 kW < Q < 800 kW	Floor area: **40 m²**, headroom: **3,20 m**
800 kW < Q < 1.630 kW	Floor area: **50 m²**, headroom: **3,50 m**

Gas boiler plant dimensions if $Q_{building}$ > 140 kW

The **floor area** of the gas boiler plant can also be calculated using the following formula:

- **$A = 20 + 0{,}022 \cdot (Q / 1000)$ [m²]**
    - Q represents the overall heating demand of the building [kW]

Gas boiler plant and domestic boiler with heat pump

2.1.6. Solid Fuel Boiler Plant Spaces

If the building has a Solid Fuel Boiler Plant, the following auxiliary spaces and rooms must be created. Q represents the overall heating power demand of the building [W]:

- **Solid Fuel Boiler plant**, **A = 15,1 + 0,06 · (Q / 1000) [m²], h = 3,10 ... 5,00 m,**
- **Solid Fuel Storage unit, A = 0,2 · (Q / 1000) [m²], h = min. 2,00 m,**
- **Slag or Sludge storage unit**, **A = 0,04 · (Q / 1000) [m²], h = min. 2,00 m,**
- **Auxiliary Service unit** (resting area and sanitary unit) for the personnel over 140 kW heat performance demand).

The boiler plant, fuel storage and slag storage units must be located along the external envelope of the building. Adequate ventilation, transportation and service route to the units must be ensured. The slag storage can also be allocated on the building plot, detached from the building (considering fire-regulations).

ArchiEXPO, IBM, Hurst Boiler, Direct Industry, ZBG, HTS

Solid fuel boiler plant and bio-fuel boiler with heat exchanger

2.1.7. Explosion Pressure Relief Surface

An explosion relief rupture surface (panel, wall, roof, etc.) is a safety structure to protect equipment, buildings and inhabitants against excessive internal, explosion-incurred pressures, by means of pressure relief.

Such pressure relief surface must be installed for **Gas Boiler Rooms or Plants**, if:

- the **individual** heat performance of a gas boiler is more than **140 kW**,
- the **total** heat performance of the gas boilers are more than **1.400 kW**.

If the explosion pressure relief surface is an **external wall**, the minimal area of the pressure relief vent can be calculated using this formula:

- **$A = 0,2 \cdot V_{boiler\ plant}$ [m²]**
    - $V_{boiler\ plant}$ represents the volume of the boiler plant room [m^3]

If the explosion pressure relief surface is a **roof structure** above the gas boiler plant, there is no need to perform any calculation, because in such case the roof structure **must be designed so**, that its entire surface will be considered as a pressure relief surface.

CS Group, Ruskin, BB, EAT

Blast louvre structure and explosion relief wall construction

2.1.8. Chimneys

Gas-supplied or **solid-fuel fired boilers, fire-places, stoves** (such as wood, coal, turf fires boilers or stoves) must be equipped with chimneys. Such chimney structures **must be indicated** on the architectural documentations sets (on elevations, sections, etc.). For further design rules and details please contact your consultant.

Chimneys of Gas Boilers

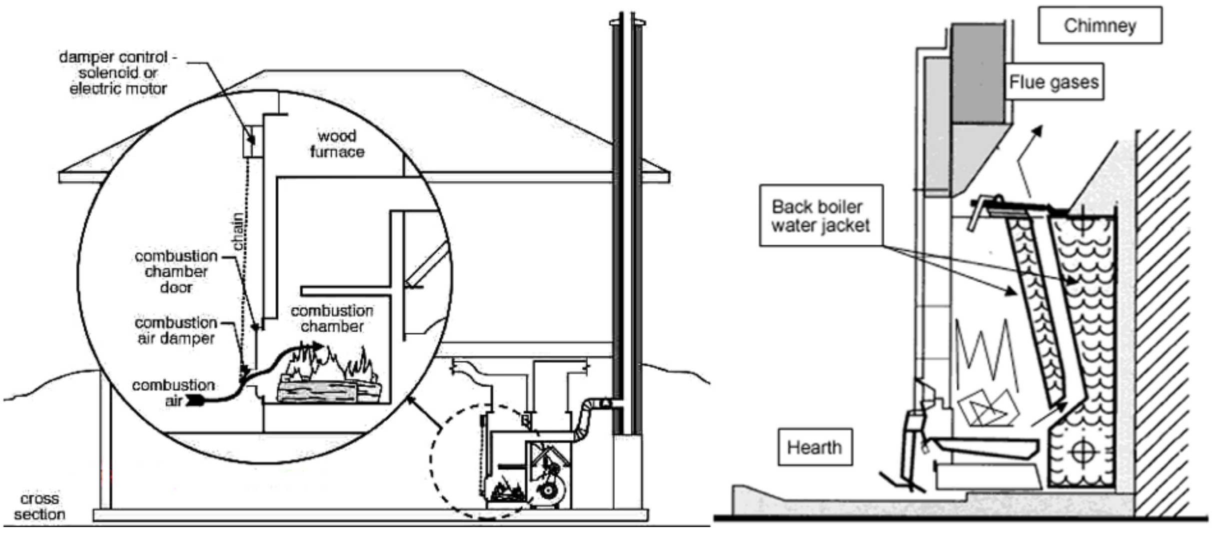
The following values provide a draft overview for the required chimney dimensions, please discuss further details with your consultant.

- Q < 24 kW Cross section: 60/100 mm Total height: 5,00 m
- Q ≈ 24 kW Cross section: 80/125 mm Total height: 25,00 m
- Q ≈ 40 kW Cross section: 100/150 mm Total height: 15,00 m

Chimneys of Solid-fuel boilers, fire-places and stoves

Every individual boiler, fire-place or stove must have its dedicated chimney. This practically means that it is not allowed to connect more than one boiler or fire-place or stove into the same chimney. Fresh air supply must always be provided through a dedicated fresh-air inlet vent system from the exterior. This may be a standalone system but it also may be part of the chimney system.

Tiled-stoves require **140/200 mm** cross section dimensions while **fire-places** require **200/250 mm** cross section dimensions, minimum height is **5,00 m**.



Schematic chimney layout of domestic solid fuel fired boiler and fire-place

2.2. Domestic Hot Water Production

2.2.1. Domestic Hot Water Plant

Such plant is required only in special cases because typically the domestic hot water tanks are placed in the main **Heating or Boiler plant**. There is no need to create a central, domestic hot water plant if

- individual, stand-alone domestic hot water boilers are used,
- gas boiler room is designed on the roof or top of the building.

If required, the domestic hot water plant must be created on the **ground floor** or on the **first basement level**. Adequate transportation and service route must be ensured. The room must have a double-leaf door opening outwards.

The minimal floor area of such plant should be determined based on the size and headroom of the **Boiler Room or Plant** as described in the **2.1. Heating** chapter of this design aid.

ZBG, Saz Boilers, JMP, SAV, Rentech

Domestic hot water plant of a health center

2.2.2. Water Pressure Booster Plant

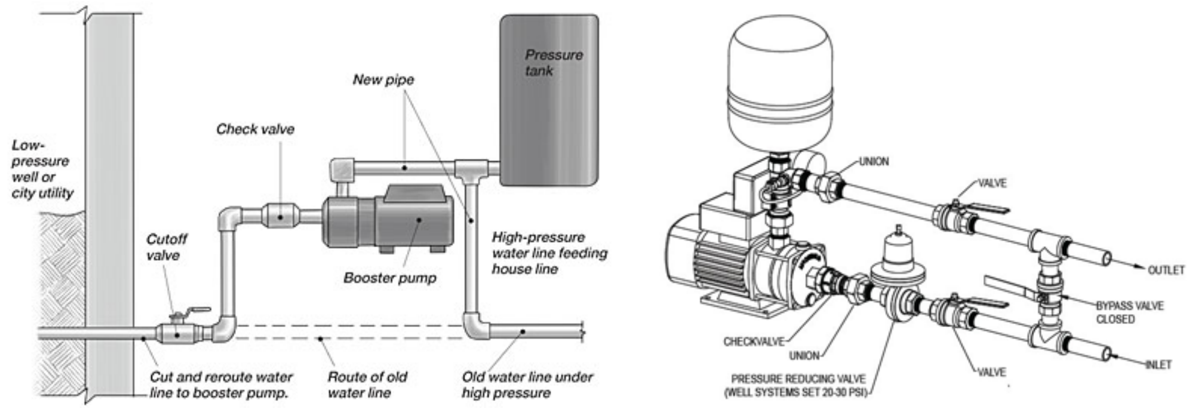
Such systems is **required only if the elevation height** of the design building **is more than 20 meters**. Water pressure boosters require a separate plant room located on the ground floor or on the first basement level. Adequate transportation and service route to such machine room must also be ensured. The room must have a double-leaf door opening outwards.

The minimum floor area **A [m^2]** and headroom **h [m]** the of the water pressure booster plant should be:

Water demand V [m^3/day]	**Water Pressure Booster Plant dimensions**
V < **41** m^3/day	Floor area: **50 m^2**, headroom: **3,00 m**
41 m^3/day < V < **153** m^3/day	Floor area: **50-135 m^2**, headroom: **3,70 m**
V > **153** m^3/day	Floor area: **135 m^2**, headroom: **4,60 m**

Water pressure booster plant dimensions

Grundfos, HT Pumps, Minibooster, Toolstation



Water pressure booster system schematic layout

2.3. Ventilation, Cooling

If a dedicated **Ventilation Plant** is required, it must be located on the **ground floor**, on the **first basement level** or on the **top of the building**. It should have a door opening outwards. Adequate transportation and service route to such machinery room must also be ensured. It is also important to provide direct connection with the exterior to enable uninterrupted fresh air supply.

The following values provide estimated ventilation requirements, **V_{air} [m^3/h]** for some building types and sizes. Please review the estimated values with your consultant.

Building type	Ventilated spaces	Ventilation demand, V_{air} [m^3/h]
Residential buildings and units	WC, exhaust	**50** m^3/h
	Shower, exhaust	**70** m^3/h
	Bathroom, exhaust	**30** m^3/h
	Living spaces with heat-exchanger units	**2** m^3/h
Offices	Office spaces	**3,6 - 6** $m^3/h \cdot A\ m^2$
	Meeting rooms	**10** $m^3/h \cdot A\ m^2$
	Car parking	**200 - 300** m^3/h per car
Educational	Ventilation with heat-exchanger units	**36** m^3/h per person

Estimated ventilation demands of building types

The required size and shape of the ventilation machinery room depends on the required fresh air, V_{air} [m^3/h] demand.

- **Residential ventilation units** (V_{air} < 600 m^3/h) can be mounted on walls or installed in kitchen cabinets or in cupboards. No need to provide a dedicated ventilation room, but it is important to ensure ventilation tubes connecting the unit with the exterior and having **160-200 mm** tube diameter.

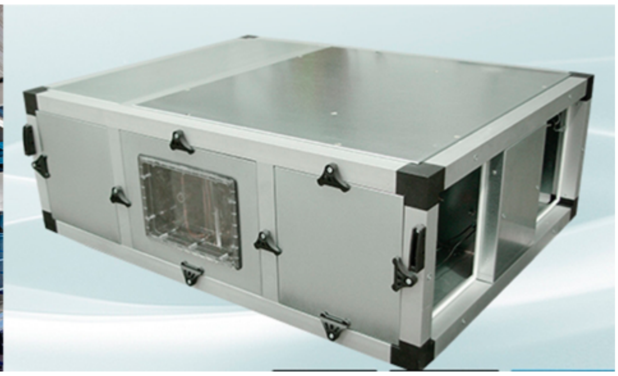
- **Compact ventilation units** (V_{air} < 2500 m^3/h) can also be mounted on walls and on ceilings and do not require dedicated rooms. Ventilation tubes connecting the unit with the exterior and having **160-200 mm** tube diameter must also be installed.

- **Ventilation Systems** providing high fresh air demand are designed by HVAC engineers considering various complex criteria. These require one or more dedicated ventilation machinery plant rooms. The ventilation machinery plant room sizes and shapes can be estimated using the following criteria:
    - The **width** of the room should be 2,5-times the width of the ventilation units to provide clearance for machine maintenance.
    - You may use the $\mathbf{A = 19 + 1{,}43 \cdot (V_{air} / 1000)\ [m^2]}$ formula to determine the required room size, or use the following estimated **area** and **head rooms**:

Ventilation demand V_{air} [m^3/h]	**Ventilation plant dimensions**
$\mathbf{V_{air}}$ < 20.000 m^3/h	Floor area: **30 - 50 m^2**, headroom **= 2,65 m**
20.000 < $\mathbf{V_{air}}$ < 30.000 m^3/h	Floor area: **50 - 60 m^2**, headroom **= 3,00 m**
30.000 < $\mathbf{V_{air}}$ < 40.000 m^3/h	Floor area: **60 - 80 m^2**, headroom **= 3,50 m**
$\mathbf{V_{air}}$ > 40.000 m^3/h	Floor area: **> 80 m^2**, headroom **= 4,00 m**

Ventilation plant dimensions

ArchiEXPO, VENTS, Direct Industry,



Ventilation plant and compact ventilation unit with heat-exchanger

2.4. Electric Power Supply

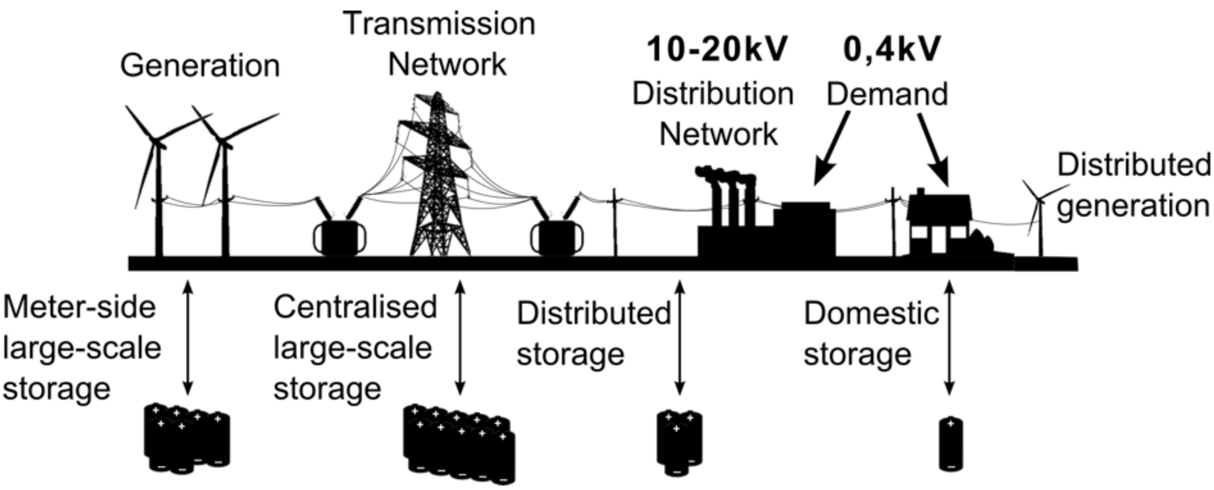
The necessary rooms and areas required for the electric power supply and distribution in the buildings depends on various criteria:

- Electric power grid infrastructure characteristics (0,4 kV, 10kV, 20kV),
- Total electric power demand of the building, P [kW],
- Backup and emergency power supply system requirements,
- Use of renewable energy systems for electric power generation.

2.4.1. Electric Power Grid Infrastructure

The location of the building determines its electric power infrastructure and supply methods:

- In case of **urban**, **downtown** areas typically both "low-power" **0,4 kV** as well as "mid-power" **10kV** power networks are available **under ground**.
- In case of **suburban** and **rural** areas typically both "low-power" **0,4 kV** as well as "mid-power" **20kV** power network is available via **open-air cables and column post.**



Electric power grid network schematics (E-ON)

0,4 kV (low-power) electric grids are designed so that these typically have the following **surplus** or "**free"** power capacity [kW]:

- **200 kW** surplus power capacity in case of **urban or downtown** areas,
- **100 kW** surplus power capacity in case of **suburbian** or **rural** areas.

Most of the electrical devices in a buildings are utilizing the 0,4 kV (400/230 V) network. If the **total electric power demand** [kW] of your building exceeds the available surprus 0,4 kV power capacaity, **a transformer station** must be installed and powered using the 10kV or 20kV power grid.

This practically means, that it is necessary to install a transformer station, if the total electric power demand of your building exceeds:

- **200 kW** and its located in an **urban or downtown** area, or
- **100 kW** and its located in a **suburban or sural area.**

Please read the dedicated paragraph about **transformer stations** to find out more about their space requirements and location options.

You may identify the available electric power network of your building site by taking a couple of photos of the environment. **Please discuss the available and required power grid network characteristics with your consultant.**

2.4.2. Electric Power Demand

The total electric power demand **P [kW]** of the building may vary between the range of a couple of 10 kW and couple of 100 kW, depending on the size and the function of the building.

The following table provide an electric power demand estimation for certain building functions and sizes. Please review these with your consultant!

Building type	Total floor area, A [m^2]	Power Demand, P [kW]
Residential	A < **500** m^2	**50** kW
	500 m^2 < A < **1000** m^2	**75** kW
	> **1000** m^2	**A** m^2 · **60** W/m^2
Office	A < **1000** m^2	**150** kW
	1000 m^2 < A < **2000** m^2	**200** kW
	A > **2000** m^2	**A** m^2 · **175** W/m^2
Educational	A < **1000** m^2	**100** kW
	1000 m^2< A < **2000** m^2	**150** kW
	A > **2000** m^2	**A** m^2 · **125** W/m^2
Health care	A < **1000** m^2	**200** kW
	1000 m^2 < A < **2000** m^2	**400** kW
	A > **2000** m^2	**A** m^2 · **300** W/m^2

Estimated electric power demand of building types

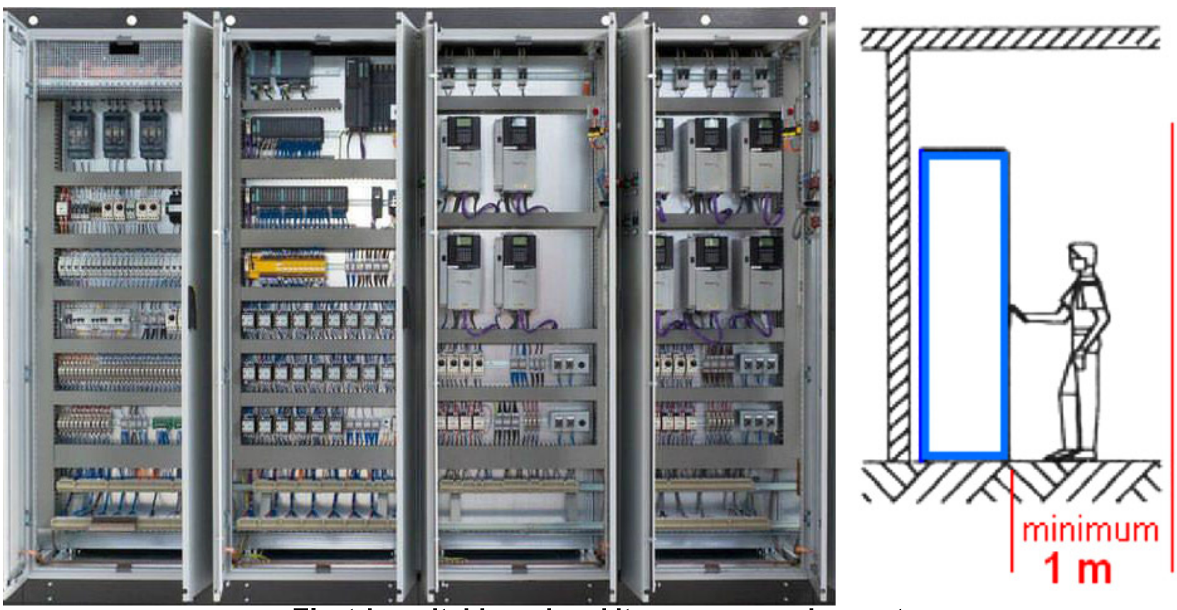
For a more detailed calculation of the electric power demand of the building, you may use the calculation method presented in **Annex D** of this design aid (such detailed calculation is not part of the obligatory task).

2.4.3. Electric Cabinets and Switch Rooms

Every building connected to the electric power grid must include at least one electrical power utility cabinet or room. This contains the power meter(s) and main power switches to be used in case of fire or power maintenance. At least **1,00 m clearance** must be provided for the safe access of the cabinets. The **size** of such cabinets and rooms depends of the total power demand of the building.

Electric power demand, P [kW]	Electric cabinet and room dimensions
P < **50** kW	**Wall mounted cabinet:** width: **1,20** m, depth: **0,30** m, height: **2,0** m
50 kw < P < **100** kW	**Wall mounted cabinet,** width: **2,50** m, depth: **0,30** m, height: **2,0** m
100 kw < P < **200** kW	Electric **switch room:** A = **4,00** m^2
P > **200** kW	Electric **switch room:** A = **12,00** m^2

Electric cabinet and switch room dimensions



Electric switchboard and its access requirements

Electric cabinets may be placed into accessible, dry and ventilated areas such as corridors, passages, entrances, bellow stairs, etc., but can't be located in sanitary units, storage areas or in the heating boiler rooms or water treatmant plants.

Electric switchrooms must be directly accesible from corridors and passages.

Eldon, Equipto, Direct Industry, Hammond

2.4.4. Transformer Units and Stations

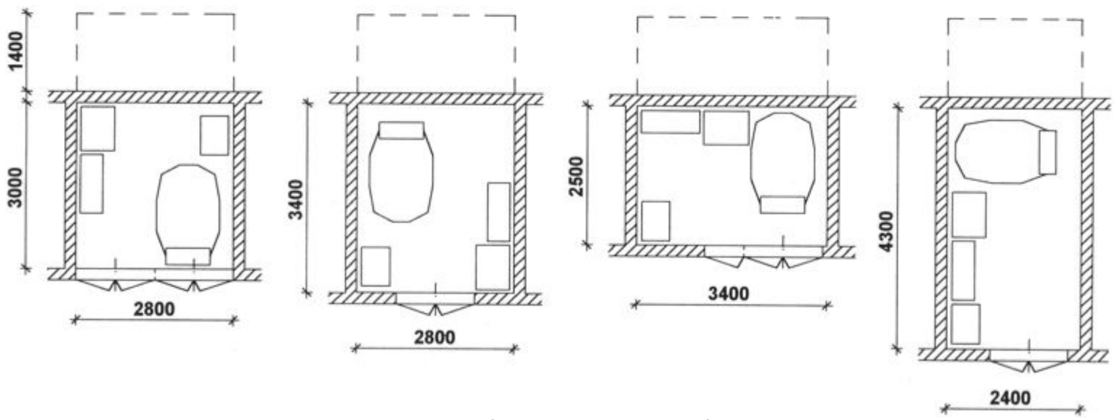
Transformer units and stations are responsible to provide **0,4 kV** "low-power" supply for building using the 10kV or 20kV "mid-power" network. Transofrmer units can be located:

- **inside** the building in a transformer room,
- **outside** of the building in a dedicated, prefabricated, uni-body transofmer station or on a column (if applicable).

The dimensions of a 630 kVA transformer is 140 · 95 · 160 cm, it's weight is 2000 kg. Column transformer units are typically smaller and lighter.

Transformer rooms within the building must meet the following criteria:

- it must be located on the **external building envelope** (one of the walls of the station must be ab external wall),
- it must be located on the **ground floor or on the first basement level**,
- if located on the **first basement level**, a **1,4 m** wide vertical service well must be provided to access the station from the outside, and it also must be accessible **from the inside** of the building,
- if located on the **ground floor** one external door must be provided towards the exterior of the building,
- the **floor area** of the transformer room is about **12 m^2**, **headroom** is **2,60 m**.



Floor plan schemes of a 630 kVA transformer station

Transformer stations located outside the building can be prefabricated blocks placed above ground or underground:

- **Maintenance access** for trucks must be provided for the stations to enable the occasional replacement of the 2000 kg transformer device (close to parking lots or access roads are good locations for this reason)

- The **size** of the prefabricated station is **2,00 · 3,00 · 1,60 m.**

ArchiEXPO, Alfen, BetonBau, Hotlab, Ormazabal, Direct Industry, Omexom, SEL

Transformer stations outside the building (above ground and underground)

Column transformer stations

2.4.5. Backup and Emergency Power Supply

Depending on the **function** of the building, and the **possible danger** caused by the absence of electric power provided from the grid (hospitals, concert halls, factories, airports, fire stations, etc.), a **backup and/or an emergency power supply** systems may also be required.

The **type of the system**, the required room(s) can be determined considering:

- the total **power demand** of those electric equipment and technology that requires backup power,
- the **maximum allowed time** duration allowed between the power failure of the grid and the initialization of the backup system. How long can de building be without electric power: milliseconds or a couple of minutes?

Backup power supply system must be used if the maximum allowed time is a **couple of minutes**: such as deep freezer storages, agricultural fish farms, etc. This technically requires **diesel engine powered** generators that can be started in a minute or so.

Emergency power supply system (a.k.a. uninterrupted power supply system or UPS) must be used if the maximum allowed time can be measured in **milliseconds**: computer stations, servers, hospitals, concert halls, etc. This technically requires **battery plants and diesel generators** (battery-plants can provide UPS for a few minutes only, but this is sufficient time-frame to start the diesel power generators).

In case of certain computer stations **a couple of minutes may be sufficient** to save and shut down the computer, in such cases only a UPS battery system is adequate, no need for diesel power generators.

Diesel Engine Powered Generators

These generators can be located inside or outside the building. Appropriate fuel storage and exhaust pipe must be installed considering maintenance access, explosion and fire safety regulations. The operation of these generators generate noise and their weight is also considerable.

Approximate room size of diesel generators located **inside** the building:

- **20** kVA unit**: 4,00 · 6,00 m**, ventilation opening area: **1,80 m^2,**
- **1600** kVA unit**: 5,00 · 12,00 m**, ventilation opening area: **10,00 m^2.**

Approximate station size of a diesel generators located **outside** the building:

- **100 kVA** unit: **1,20 · 1,80 · 3,00 m**, weight: **1500 kg**, noise level: 65 Db.

CAT, Honny Power, Mega Power, Cqxz Power

Diesel engine power generators located inside and outside of the building

Battery Plants, UPS

Batteries and battery plants must have a ventilated, dry room where the temperature is between +5 and +30 °C.

Small, standalone UPS batteries (15 · 15 · 40 cm) can be used next to standalone computers. Such small units can provide emergency power for one computer only and do not require additional room or spaces.

A **battery plant** (room area: **15 - 50 m^2**) can provide emergency power supply for an entire building (hospital, office center, etc.). Such station also requires a **battery charging station** to be located next to the plant, room area: **1,5 m^2**.

Legrand, APC, UPS Power, Eaton

Battery plant and standalone UPS installation

2.4.6. Renewable Energy Systems

Renewable energy sources may also be used to generate electric power on the site of the building. Most common systems are the **Photo-Voltaic (PV)** panels using solar energy, but household **wind- or water turbines** may also be considered.

Household wind- and water turbines
Bergey, Gaia Wind, Ennera, Enessere, UGE, Tuge

The installation of **Photo-Voltaic (PV) panels** require the following considerations:=

- PV panel size: **80 cm x 150 cm,** thickness: **4 - 6 cm,** weight: **15 - 30 kg,**
- Generated electric power: **160 - 360 W/panel (0,16 - 0,36 kW/panel),**
- Preferred orientation is **south** (south-east, south-west), close to **horizontal** and **vertical** installation positions may also be used,
- If **electric** utility **grid** is **not available** close to the building site, the PV panel installation requires a **battery cabinet** for energy storage,
- If electric utility **grid** is **available** on site the PV panel installation requires a **converter** from 12V or 24V Direct Current (DC) to 230V or 110V Alternating Current (AC)**,** and a separate energy meter.

LG, Canadian Solar, Europe Solar Store, Sharp

Photo-Voltaic (PV) panel installation examples on roofs

Photo-Voltaic (PV) panel installations as plants and as shading devices

2.5. Elevators

Elevators and escalators may require relatively high electric energy power consumption while also require additional room to provide adequate installation.

2.5.1. Industrial Elevators

Industrial elevator systems (car-parking and lifting system, etc.) require additional research based on the function, technical requirements and load. Please discuss the technical details of such systems with your consultant.

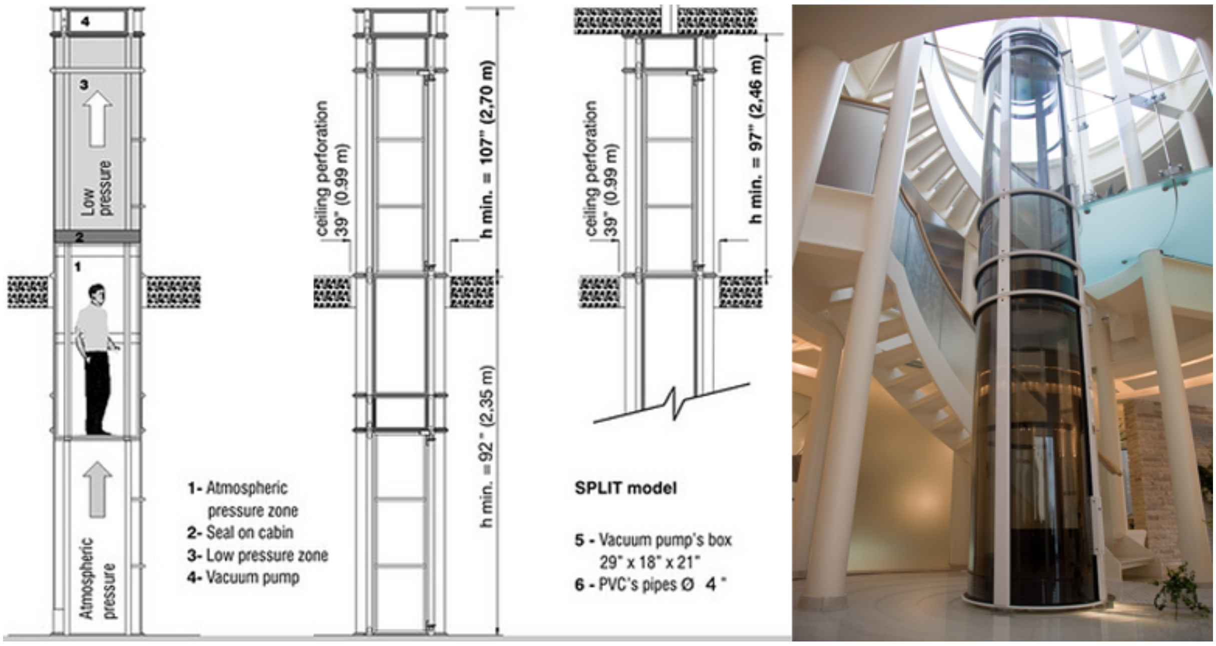
2.5.2. Personal Elevators

The technology and electric power demand as well as the required room and clearance of personal elevators depends on the number of persons they carry and the number of floors they operate on.

Pneumatic Elevators

Such personal elevators can be used in residential buildings or smaller public buildings and can carry 1 - 3 persons, across a couple of 1 - 4 floors. Their main advantage is that they do not require additional machinery room.

Hybrid Elevator, Vacuum Elevator



Pneumatic elevator vertical layout and photo

Gearless and Geared Traction Elevators

Such elevators are used be used in high-rise and public buildings across many floors carrying 4 - 20 persons. Such elevators usually require an additional machinery room located at the lower end or upper end of the elevator well. "Machine-roomless" elevators are also available for certain number of persons and floors.

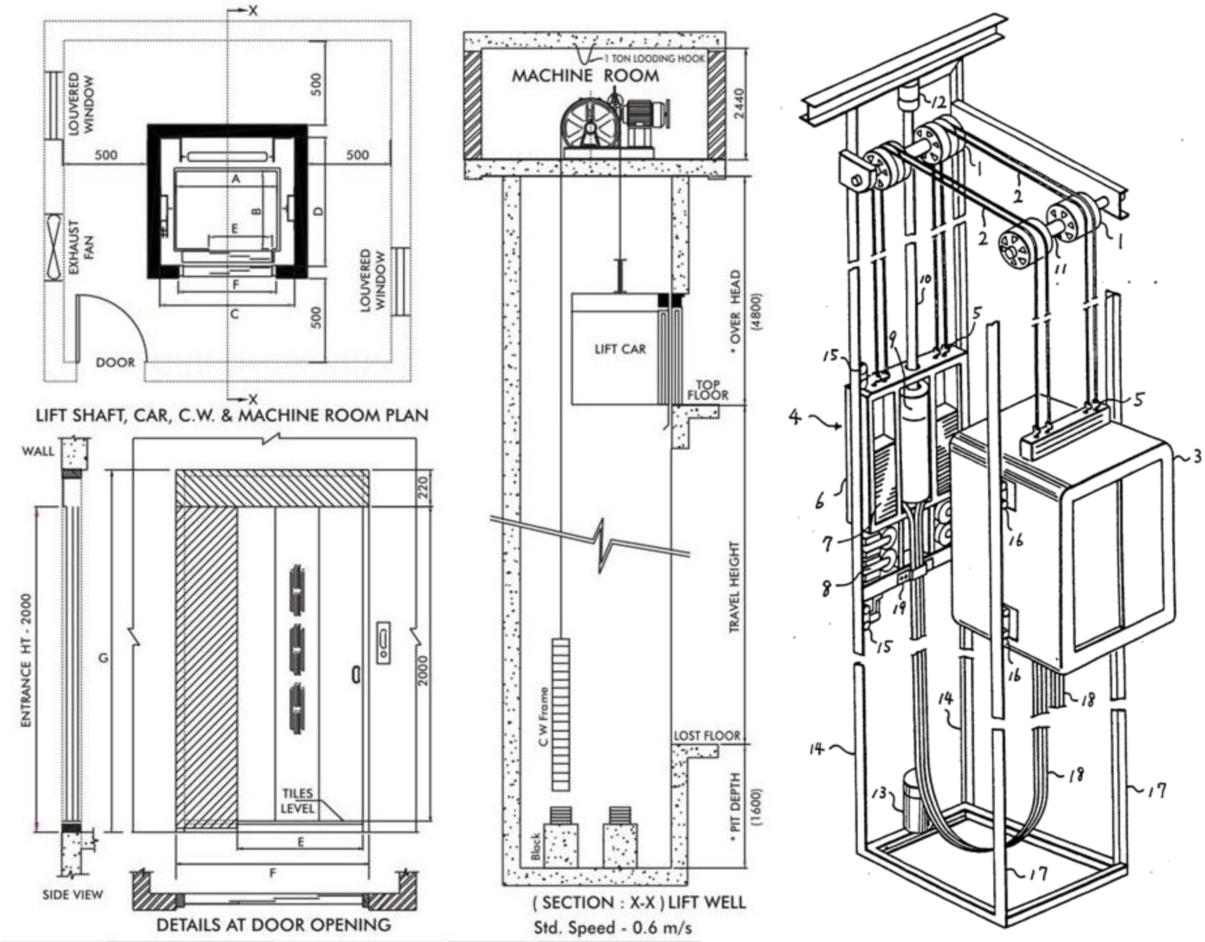
OTIS, Kone, Schindler, Thyssen, Mitsubishi, Fujitech, Toshiba, Hitachi

Elevator for 4 persons, max. **15 floors:**

- Elevator well dimensions: **1,40 · 1,40 m**, additional **1,20 m** vertical clearance required bellow the lowest floor level
- Machinery room size: **2,50 · 2,50 m**, headroom: **2,00 m**
- Electric power consumption: **12 - 30 kW**

Elevator for 6 persons, max. **15 floors:**

- Elevator well dimensions: **1,60 · 2,55 m**, additional **1,25 m** vertical clearance required bellow the lowest floor level
- Machinery room size: **2,50 · 3,20 m**, headroom: **2,50 m**
- Electric power consumption: **20 - 50 kW**



Traction elevator plan layout and axonometry

3. Building Energy Performance

The building energy performance must be verified and calculated based on the current Hungarian requirements. This regulation requires validating and checking the building energy characteristics at **three different levels**.

This design aid presents simplified calculation method to all three levels, namely:

3.1. determine the **overall building energy performance** (obligatory task),

3.2. validate the **heat transfer coefficients** of the individual building structures (*part of the detailed semester task, Annex B*),

3.3. check the **specific heat loss factor** of the building envelope (*part of the detailed semester task, Annex C*).

Please note that only the verification and rating of the Building Energy Performance is part of the standard, obligatory task.

3.1. Overall Building Energy Performance

The energy performance of a building is expressed considering the total, **annual amount of primer energy (E_p)** consumed by the technical installations of the building systems (heating, ventilation, hot water production, cooling, lighting) related to the **total heated floor area**.

The **primal energy consumption** is based on the energy demand of the building systems and it also considers the various losses as well as the additional electric energy required to operate the systems throughout the entire year.

Depending on the characteristics of the energy sources, a **primal energy conversion factor (e_{primal})** should be applied.

Energy Sources	**e_{primal} value**
Electric energy (peak)	**2,50**
Electric energy (off peak)	**1,80**
Natural gas	**1,00**
Fuel oil	**1,00**
Coal	**0,95**
District heating	**1,20**
District heating with co-generator	**1,12**
Wood, biomass	**0,60**
Renewable energy	**0,00**

e: primal energy conversion factors

The following table presents estimated values for the annual energy demand of the various building types and systems considering the Hungarian, heating oriented climate characteristics.

Building type	**Heating** [Wh/m2a]		**Ventilation** [Wh/m2a]	**Cooling** [Wh/m2a]	**Hot water** [Wh/m2a]	**Lighting** [Wh/m2a]
	q_{heat}	p_{heat}	$p_{ventilation}$	$p_{cooling}$	$p_{hot\ water}$	$p_{lighting}$
Residential	**40**	**3**	**30**	**25**	**40**	**8**
Offices	**30**	**2**	**45**	**45**	**15**	**22**
Educational	**55**	**4**	**45**	**10**	**20**	**12**
Industrial	**30**	**2**	**35**	**15**	**20**	**10**

Floor area specific annual heating energy demand (q) and annual electric energy demand of the various building systems (p).

Please note that these are rough, estimated values. Adjustments are necessary for certain building types, please contact your consultant for further instructions!

The **annual primer energy demand** of the various building systems (heating, ventilation, cooling, hot water production and lighting) may be forecasted using the above values, the **primal energy conversion factors (e_{primal})** and the total heated floor area, **A [m²]** of the building:

$$E_{heating} = A\,(q_{heating} \cdot e_{heating\ primal} + p_{heating} \cdot e_{electric\ primal})\ [Wh/m^2a]$$

$$E_{ventilation} = A \cdot p_{ventilation} \cdot e_{electric\ primal}\ [Wh/m^2a]$$

$$E_{hot\ water} = A \cdot p_{hot\ water} \cdot e_{hot\ water\ primal}\ [Wh/m^2a]$$

$$E_{lighting} = A \cdot p_{lighting} \cdot e_{electric\ primal}\ [Wh/m^2a]$$

$E_{renewable}$: should be estimated based on the **area of the renewable systems**:

- **PV panels** may produce about **360.000 Wh/m²a** electric energy in a year,
- **Solar collectors** may produce **590.000 Wh/m²a** energy in a year in Hungary.

The **annual primer, energy (E_p)** demand of the building can be forecasted using the following equation (please note that the annual lighting energy demand may be neglected for residential buildings):

$$E_p = (E_{heating} + E_{ventilation} + E_{hot\ water} + E_{lighting} - E_{renewable})\ /\ 1000\ [kWh/m^2a]$$

To be able to **rate** the building energy performance we must **compare** the **calculated** building energy performance (E_p) value with the values provided by the **regulations** (E_r).

There are specific **regulations** for specific building functions and building shell area and building volume (A/V) ratios describing the **maximum allowed** building energy consumption, according to the table.

A/V ratio	E_p Residential [kWh/m^{2}a]	E_p Office [kWh/m^{2}a]	E_p Educational [kWh/m^{2}a]
A/V ≤ **0,3**	**110**	**132**	**90**
0,3 ≤ A/V ≤ **1,3**	**74 + 120 · (A/V)**	**94 + 128 · (A/V)**	**40,8 + 164 · (A/V)**
A/V ≥ **1,3**	**110**	**260**	**254**

E_r: primal energy consumption values provided by regulations

3.1.1. Building Energy Performance Classification

To **classify** (A+, A, B, C, D, E, F, G, H, I) the building energy performance of the building we must **compare [%]** the **calculated (E_p)** overall building energy performance value to the value described by the **regulation (E_r).**

$$100 \cdot E_{performance} / E_{regulation} \ [\%]$$

According to the calculated ratio [%] value, the following **classification classes** may be determined. For instance, if the calculated % ratio is between 96-100% then the "C, According to requirement" classification rating should be indicated and highlighted.

Classification classes		Ratio [%]	Classifications
A+	A+	< 55	Very energy efficient
A	A	56 - 75	Energy efficient
B	B	76 - 95	Better than requirement
C	C ◄	**96 - 100**	**According to requirement**
D	D	101 - 120	Close to requirement
E	E	121 - 150	Better than average
F	F	151 - 190	Average
G	G	191 - 250	Close to average
H	H	251 - 340	Weak
I	I	341 >	Bad

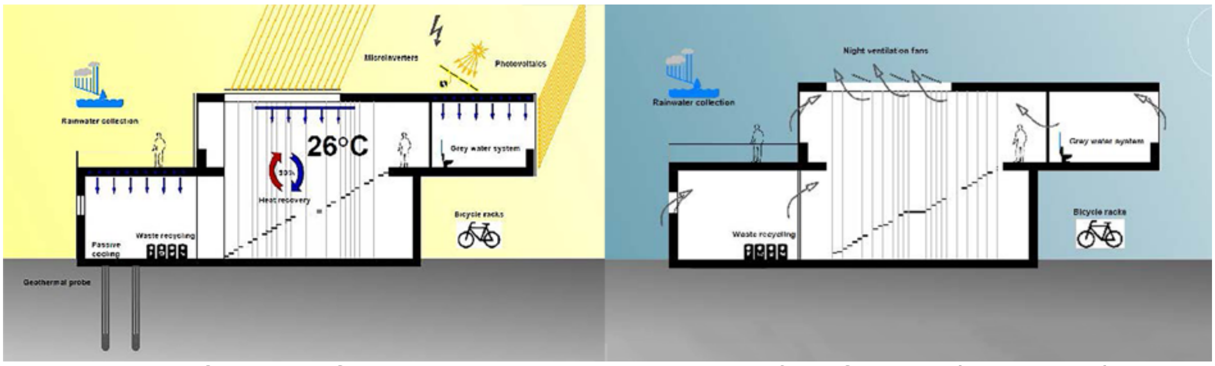
Building Energy Performance classification

Please note that the overall building energy performance must reach A+, A, B or C class to receive an approval.

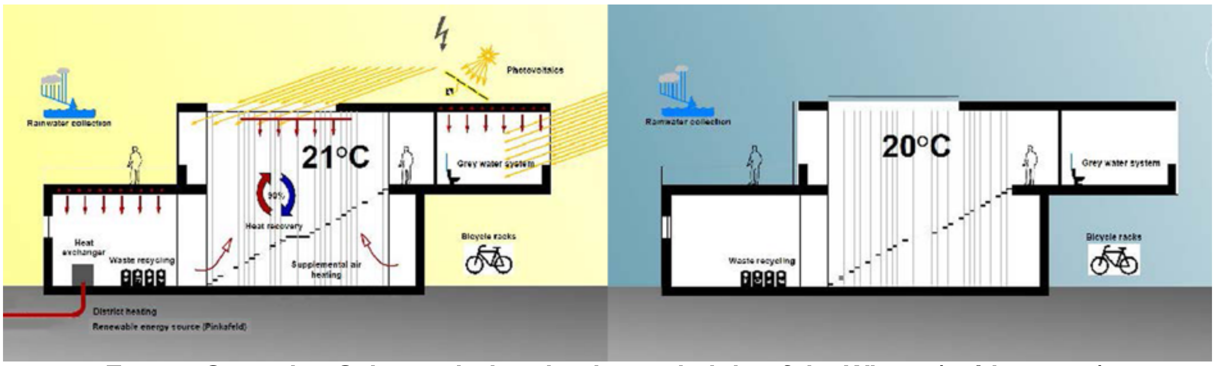
3.1.2. Renewable Energy Systems and Operations

Considering the current energy regulations and design rules, 25% of total energy use of the building must be supplied utilizing renewable energy sources.

Please prepare a draft analysis of applied renewable technologies: make a list of the planned renewable systems and briefly describe their application requirements in the actual building design. (heat pumps, solar collectors, PV panels, wind- water plants, etc.). Create draft energy operation schemes (preferably using min. A5 size schematic drawing) displaying the hot- and the cold seasons operation characteristics during day and night.



Energy Operation Scheme during the day and night of the Summer (hot season)

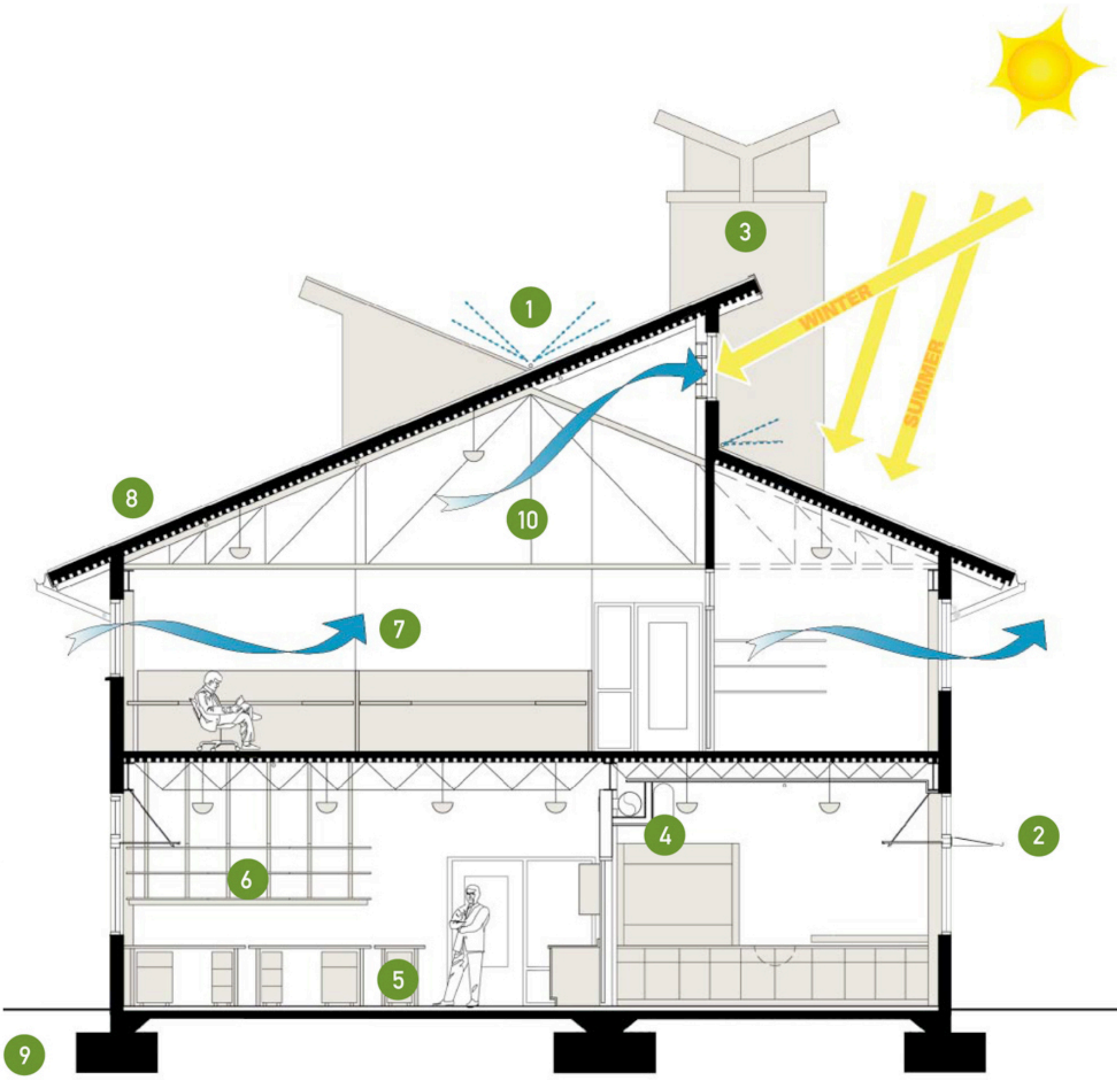


Energy Operation Scheme during the day and night of the Winter (cold season)

Building Energetics and Services

COMPLEX 1 & DIPLOMA

Design Aid Annexes



Design Aid Annexes

Annex B: Heat Transfer Coefficients

Please note that the heat transfer coefficients check of the composite structures is part of the extended, detailed task only.

The **average heat transfer coefficient** value - the U value [W/m^{2}K] - of all **composite structures** (external walls, roofs, slabs on ground) of the external building skin must meet specific requirements. The average heat transfer coefficient value of **transparent structures** (glazed systems, windows, skylights) must also include window frames and structural systems supporting the glazing.

The following table lists the required heat transfer coefficient values, please make sure that all composite and transparent structures on the external building skin meets these values. If you do not wish to perform U value calculations, you may choose composite structures from a list. Please ask your consultant for more information.

Building Structure	**Heat transfer coefficient requirement U value [W/m^{2}K]**
External wall	0,45
Wall dividing heated and unheated spaces	0,50
Flat roof	0,25
Attic floor slab	0,30
Floor slab above external space (eq. arcade)	0,25
Bas basement slab of an unheated basement	0,50
Window (wood or plastic frame)	1,60
Window (metal frame)	2,00
Window (if area is smaller than 0,50 m^2)	2,50
Curtain wall, transparent wall	1,50
Skylight having custom geometries	2,50
Roof light located in the plane of the roof	1,70
Door or gate on the external building envelope	3,00
Door between heated and unheated spaces	1,80

Heat transfer coefficient requirements of the building envelope

The heat transfer coefficient of composite structures may be calculated using the following formula:

$$U = \frac{1}{\frac{1}{\alpha_e} + \sum \frac{d_j}{\lambda_{j,be}} + \frac{1}{\alpha_i}} \ [W/m^2K]$$

where:

- α_e is the heat transfer coefficient on the external side [W/m²K]
- α_i is the heat transfer coefficient on the internal side [W/m²K]
- d_j is the thickness of the layer [m]
- λ_{be} is the heat conduction coefficient of the built layer [W/mK]

The heat conduction coefficient of the built layer (λ_{be}) differs from the heat conduction factor provided by the manufacturer, because it incorporates the external effects as well as certain characteristics of the realized composite structure. This can be calculated using the following formula:

$$\lambda_{be} = \lambda + (1 \cdot \kappa) \ [W/mK]$$

where:

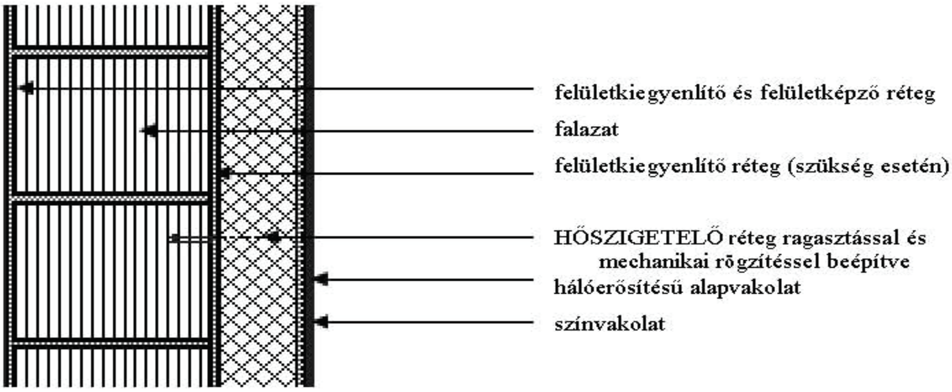
- λ is the heat conduction coefficient provided by the manufacturer [W/mK]
- κ is the correction factor, its value may be determined using specific, dedicated tables. Please contact your consultant for further details.

Please note that it is also possible to ensure an appropriate heat transfer coefficient for the composite building structures, if you **select a composite structure that has a known U value**.

The following pages list various **composite structures**, and display the **U values** of the structures in relation to the **thickness of the skins**. For further details and for English translation of these tables please contact your consultant!

Please note that not all the listed skin thicknesses will result appropriate heat transfer characteristics for the structure. Do not forget to keep in mind the U value requirements listed in the table of the previous page.

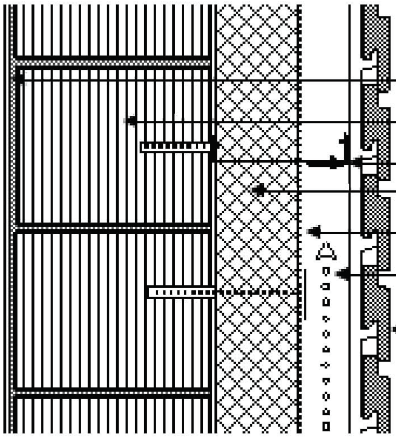
Egyhéjú fal ragasztott és mechanikai rögzítésű hőszigeteléssel, homlokzati vékonyvakolattal



Falszerkezet		Rétegtervi átlagos hőátbocsátási tényező U (W/m²K) **				
		Hőszigetelő réteg vastagsága, cm				
eleme (anyaga)	vastagsága cm	0	6	8	10	12
Kisméretű tégla	38			0,40 - 0,44	0,34 - 0,37	0,30 - 0,32
B30 blokk	30			0,40 - 0,43	0,34 - 0,37	0,30 - 0,32
Soklyukú tégla	38		0,43 - 0,45	0,36 - 0,39	0,31 - 0,33	0,27 - 0,29
HB 38 blokk	38		0,36 - 0,38	0,31 - 0,33	0,27 - 0,29	0,24 - 0,26
UNIFORM 14	30		0,42 - 0,44	0,35 - 0,38	0,30 - 0,33	0,27 - 0,29
MÁTRATHERM 38 N+F *	38		0,31 - 0,32	0,27 - 0,29	0,24 - 0,26	0,22 - 0,23
MÁTRATHERM 30 N+F *	30		0,36 - 0,38	0,31 - 0,33	0,27 - 0,29	0,24 - 0,26
BAUTHERM 38 N+F *	38		0,32 - 0,33	0,28 - 0,29	0,25 - 0,26	0,22 - 0,24
BAUTHERM 30 N+F *	38		0,35 - 0,37	0,30 - 0,32	0,27 - 0,29	0,24 - 0,26
POROTHERM 44 N+F *	44	0,34	0,24 - 0,24	0,21 - 0,22	0,20 - 0,20	0,18 - 0,19
POROTHERM 38 N+F *	38	0,41	0,27 - 0,28	0,24 - 0,25	0,22 - 0,23	0,20 - 0,21
POROTHERM 30 N+F *	38		0,30 - 0,31	0,26 - 0,28	0,24 - 0,25	0,21 - 0,23
YTONG 37,5 P2-05 *	37,5	0,32	0,23 - 0,23	0,21 - 0,21	0,19 - 0,20	0,17 - 0,18
YTONG 37,5 P4-06 *	37,5	0,37	0,25 - 0,26	0,23 - 0,23	0,20 - 0,21	0,19 - 0,20
YTONG 30,0 P2-05 *	30	0,40	0,26 - 0,27	0,24 - 0,25	0,21 - 0,22	0,20 - 0,21
Monolit vasbeton fal	15 - 20				0,40 - 0,44	0,34 - 0,37

* Hőszigetelő falazóhabarccsal falazva
** A hőátbocsátási tényezők számítása során figyelembe véve az acél rögzítő elemek (átlagosan 7 db/m², ∅ 5 mm acél) hőhíd-hatása.

Kéthéjú fal szellőztetett légréteggel, szerelt homlokzatburkolattal



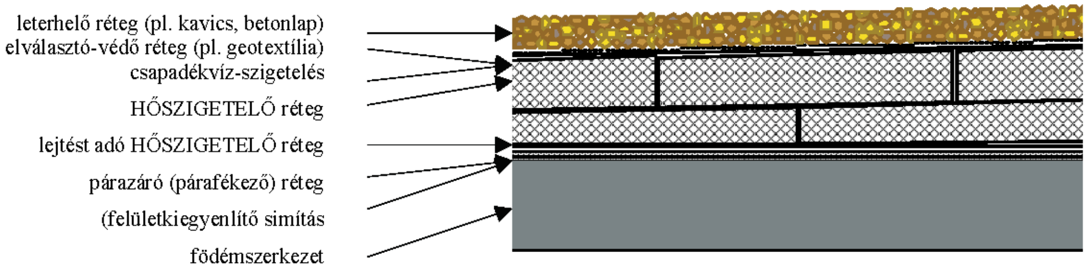
Teherhordó fal		Rétegtervi átlagos hőátbocsátási tényező U (W/m^2K) **				
		Hőszigetelő réteg vastagsága, cm				
Eleme (anyaga)	vastagsága cm	0	6	8	10	12
Kisméretű tégla	38				0,38 - 0,42	0,34 - 0,37
B30 blokk	30				0,38 - 0,42	0,33 - 0,37
Soklyukú tégla	38			0,39 - 0,42	0,34 - 0,37	0,30 - 0,33
HB 38 blokk	38		0,38 - 0,40	0,33 - 0,35	0,30 - 0,32	0,27 - 0,29
UNIFORM 14	30		0,45 - 0,48	0,38 - 0,41	0,34 - 0,36	0,30 - 0,32
MÁTRATHERM 38 N+F *	38		0,32 - 0,34	0,29 - 0,30	0,26 - 0,28	0,24 - 0,25
MÁTRATHERM 30 N+F *	30		0,38 - 0,40	0,33 - 0,35	0,30 - 0,32	0,27 - 0,29
BAUTHERM 38 N+F *	38		0,33 - 0,35	0,30 - 0,31	0,27 - 0,28	0,24 - 0,26
BAUTHERM 30 N+F *	30		0,37 - 0,39	0,33 - 0,35	0,29 - 0,31	0,26 - 0,28
POROTHERM 44 N+F *	44	0,33	0,25 - 0,25	0,23 - 0,23	0,21 - 0,22	0,19 - 0,20
POROTHERM 38 N+F *	38	0,40	0,28 - 0,29	0,25 - 0,26	0,23 - 0,24	0,21 - 0,23
POROTHERM 30 N+F *	38		0,31 - 0,33	0,28 - 0,30	0,25 - 0,27	0,23 - 0,23
YTONG 37,5 P2-05 *	37,5	0,31	0,24 - 0,24	0,22 - 0,22	0,20 - 0,21	0,19 - 0,20
YTONG 37,5 P4-06 *	37,5	0,36	0,26 - 0,27	0,24 - 0,25	0,22 - 0,23	0,20 - 0,21
YTONG 30,0 P2-05 *	30	0,39	0,27 - 0,28	0,25 - 0,26	0,23 - 0,24	0,21 - 0,22
Monolit vasbeton fal	15-20					0,39 - 0,43

* Hőszigetelő falazóhabarccsal falazva

** A hőátbocsátási tényezők számítása során figyelembe véve az acél vázszerkezet és a rögzítő elemek hatása

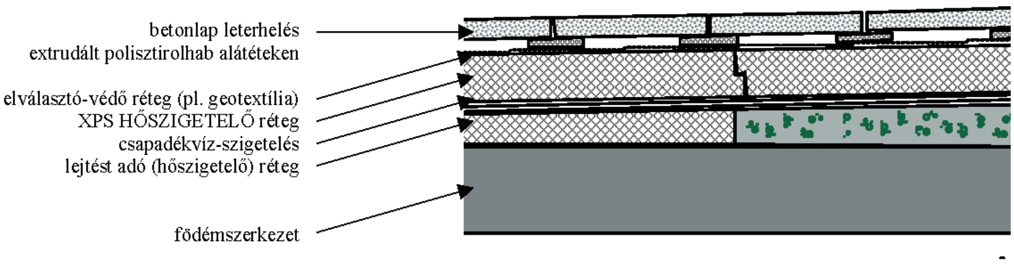
Légzáró-páraáteresztő réteg hiányában az ásványgyapot hőszigetelés hővezetési tényezőjének 25-35 %-os növekedésével, illetve a rétegtervi hőátbocsátási tényező mintegy 15– 25 %-os növekedésével lehet számolni.

Nem hasznosított egyenes rétegrendű lapostetők



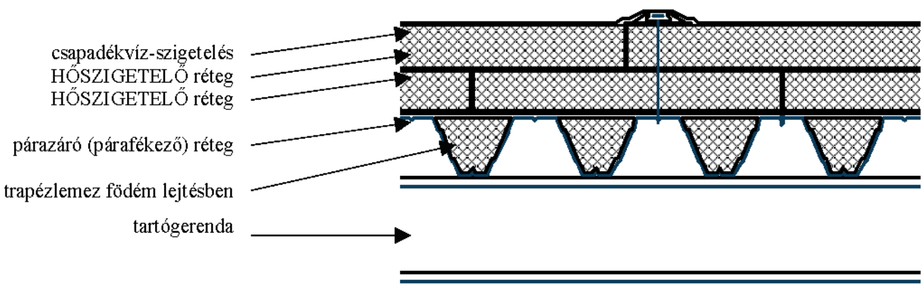
Lejtést adó réteg		Rétegtervi átlagos hőátbocsátási tényező U (W/m^2K)				
		Hőszigetelő réteg vastagsága, cm (λ = 0,040 W/mK)				
megnevezése	átlagos vastagsága, cm	**6**	**8**	**10**	**12**	**14**
Lejtésbe szabott lépésálló hőszigetelő táblák λ = 0,040 W/mK	**7**		0,25	0,22	0,20	0,18
	9	0,25	0,22	0,20	0,18	0,17
	11	0,22	0,20	0,18	0,17	0,16
	13	0,20	0,18	0,17	0,15	0,14

Nem hasznosított fordított rétegrendű és DUO tetők



Lejtést adó réteg		Rétegtervi átlagos hőátbocsátási tényező U (W/m²K)				
		Hőszigetelő réteg vastagsága, cm				
anyaga	átlagos vastagsága, cm	**10**	**12**	**14**	**16**	**18**
Kavicsbeton (λ = 1,28	**10 - 14**			0,25	0,22	0,20
Könnyűbeton (λ= 0,10 W/mK)	**10**		0,23	0,21	0,19	0,17
	14	0,24	0,21	0,19	0,18	0,16
Lejtésbe szabott expandált polisztirolhab táblák (λ = 0,040 W/mK)	**7**	0,22	0,20	0,18	0,17	0,15
	9	0,20	0,18	0,17	0,15	0,14
	11	0,18	0,17	0,15	0,14	0,13

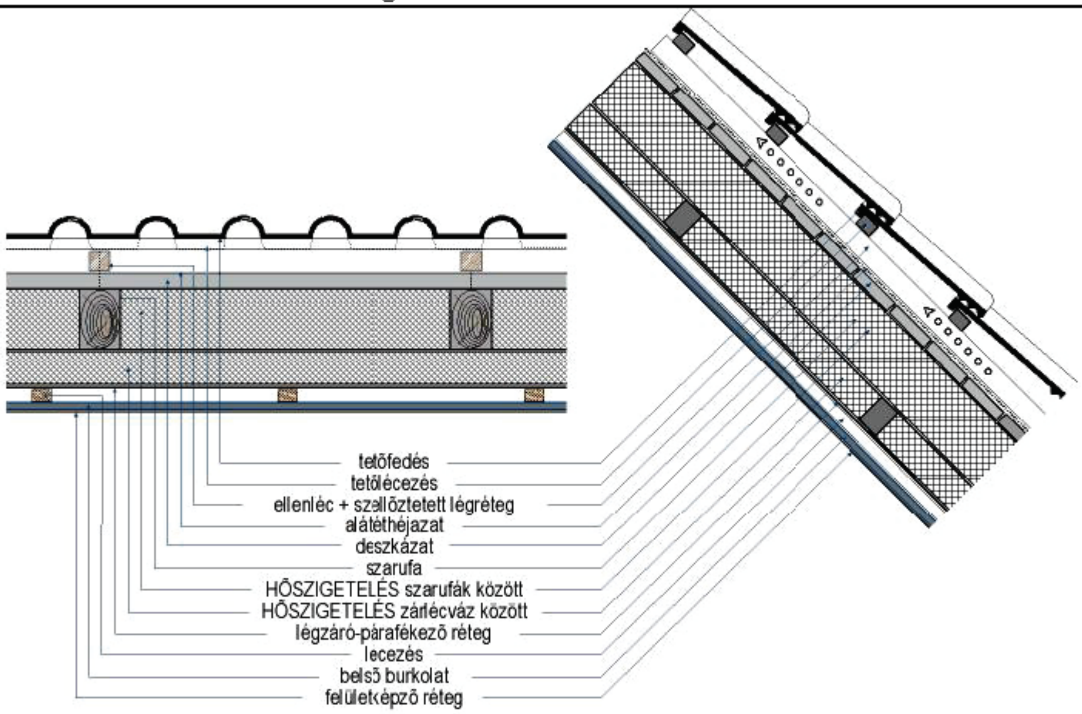
Egyenes rétegrendű könnyűszerkezetes lapostetők



Hőszigetelő anyag hővezetési tényezője λ (W/mK)	Rétegtervi átlagos hőátbocsátási tényező * U (W/m²K)				
	Hőszigetelő rétegek összvastagsága, cm				
	16	**18**	**20**	**22**	**24**
0,038	0,25	0,22	0,20	0,19	0,17
0,039		0,23	0,21	0,19	0,18
0,040		0,24	0,21	0,19	0,18

Hőátbocsátási tényezők számítása bordakitöltés figyelembe vétele nélkül
* A hőátbocsátási tényezők számítása során figyelembe véve az acél rögzítő elemek (átlagosan 3 db/m^2, ϕ5 mm acél) hőhíd-hatása.

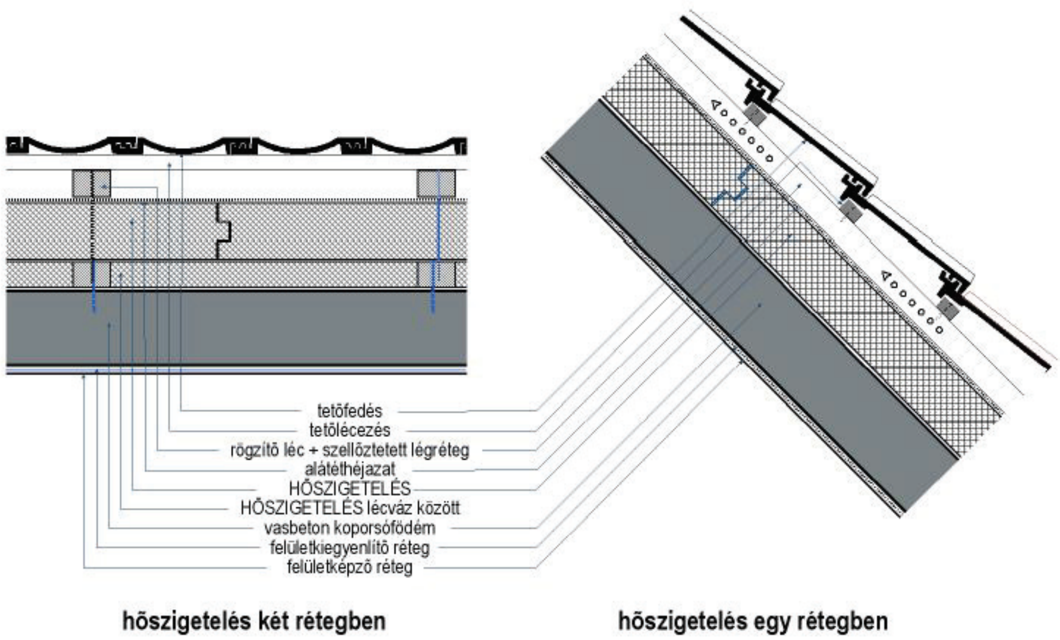
Tetőtér-beépítést határoló épületszerkezetek
Hőszigetelés a szarufák között és alatt



Tetőtér-beépítést határoló ferde fal		Hővezetési tényezők λ (W/mK)		Rétegtervi átlagos hőátbocsátási tényező U (W/m²K)					
Hőszigetelő termék (szarufák között + szarufák alatt)				Hőszigetelő rétegek vastagsága, cm					
				16 (10+6	18 (12+6	20 (14+6	22 (16+6	24 (16+8	26 (18+8
KGY	ROCKWOOL DELTAROCK+RP-V	0,033	0,037	0,25	0,22	0,20	0,19	0,17	0,16
	TOPLAN NF, KL	0,0366	0,0366		0,24	0,22	0,20		
ÜGY	UNIROLL KOMFORT + ROLLISOL	0,037	0,039		0,24	0,22	0,20	0,19	0,17
	THERWOO-filc + THERWO-roll	0,036	0,034		0,23	0,21	0,19	0,18	0,16

A hőátbocsátási tényezők számítása során figyelembe véve a szarufák (12,5%) és zárlécek (10,0%)

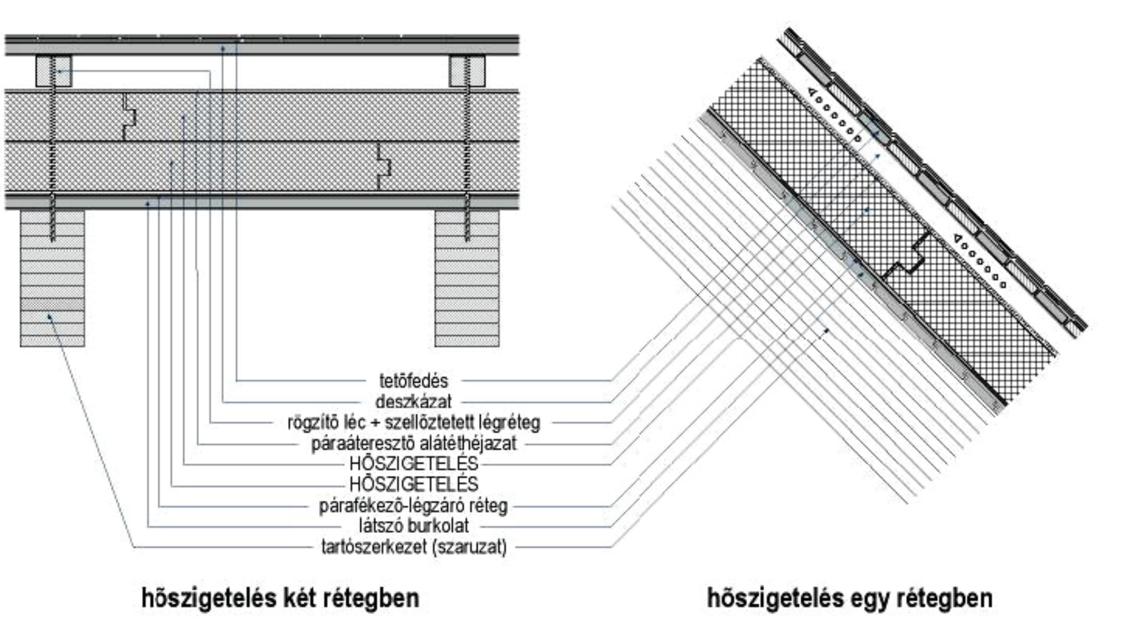
Tetőtér-beépítést határoló szerkezetek
Hőszigetelés a vasbeton koporsófödém felett



Tetőtér-beépítést határoló ferde fal		Hővezetési tényező λ (W/mK)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K)				
Hőszigetelő termékek			Hőszigetelő réteg vastagsága, cm				
			14	**16** (10+6)	**18** (12+6)	**20** (12+8)	**22** (12+10)
XPS	AUSTROTHERM XPS	0,035		(0,24)	(0,22)	(0,20)	(0,18)
	ROOFMATE TG-A	0,035		0,24	(0,22)	(0,20)	(0,18)
EPS	AUSTROTHERM AT-	0,035		0,24	0,21	0,19	0,18
	NIKECELL NC 150	0,035		0,24	0,21	0,19	0,18
PU	BACHL tecta-PUR HD-	0,030	0,24	0,21	(0,19)	(0,17)	(0,16)

* A hőátbocsátási tényezők számításakor a rögzítő elemek (1,15 cm²/m² acél) hatását, kétrétegű hőszigetelésnél pedig az alsó réteg lécbetéteink hatását (9 % faanyag) is számításba véve.
(Zárójelben) a jelenleg kétrétegű hőszigeteléssel készíthető szerkezetek U tényezői

Tetőtér-beépítést határoló épületszerkezetek
Hőszigetelés a szarufák felett

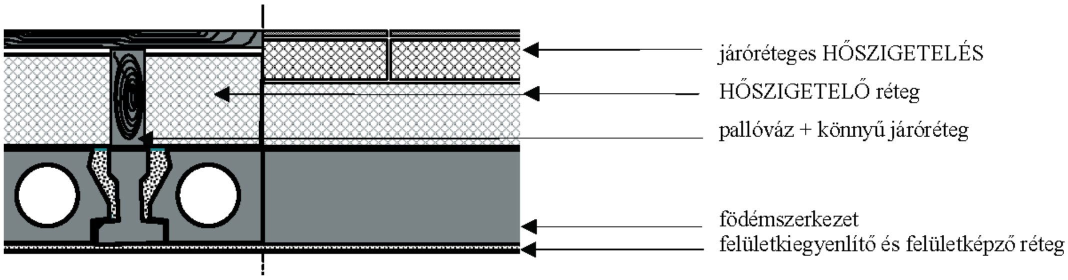


Tetőtér-beépítést határoló ferde fal		Hővezetési tényező λ (W/mK)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K)				
Hőszigetelő termékek			Hőszigetelő réteg vastagsága, cm				
			14	**16** (8+8)	**18** (10+8)	**20** (10+10)	**22** (12+10)
XPS	AUSTROTHERM XPS	0,035		(0,24)	(0,22)	(0,20)	(0,18)
	ROOFMATE TG-A	0,035		0,24	(0,22)	(0,20)	(0,18)
PU	BACHL tecta-PUR HD-	0,030	0,24	0,21	(0,19)	(0,17)	(0,16)

A hőátbocsátási tényezők számításakor a rögzítő elemek hatását (1,15 cm^2/m^2 acél) figyelembe véve

(Zárójelben) a jelenleg kétrétegű hőszigeteléssel készíthető szerkezetek U tényezői

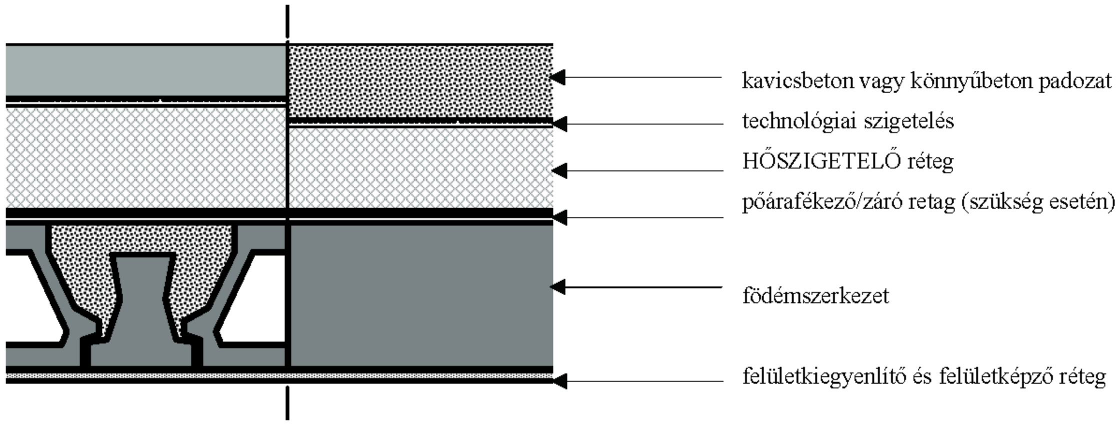
Padlásfödémek könnyű járóréteggel



Hőszigetelés		Hőszigetelő réteg vastagsága (mm)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K) ha a teherhordó szerkezet		
anyaga és terméktípusa	termékjele		Monolit vasbeton lemez-födémek	Egy. vb. gerendás és körüreges pallófödémek	Vázkerámia elemes födémek
Üveggyapot filc fapallók között	**THERWOOLIN** LHF **ISOVER** UNIROLL λ = 0,040 W/mK *	140			0,30
		160		0,28	0,27
		180	0,26	0,25	0,24
		200	0,23	0,23	0,22
Kőzetgyapot filc vagy lap fapallók között	**TOPLAN** NT, NF **ROCKWOOL** ROLLROCK **HERALAN** DP **NOBASIL** MPN λ = 0,034 – 0,039 W/mK *	140	0,28 – 0,31	0,27 – 0,31	0,26 – 0,30
		160	0,25 – 0,28	0,24 – 0,27	0,23 – 0,26
		180	0,22 – 0,25	0,22 – 0,25	0,21 – 0,24
		200	0,20 – 0,23	0,20 – 0,22	0,19 – 0,22
Expandált polisztirolhab	**AUSTROTHERM** AT-PA fagyapot járóréteggel társított expandált polisztirolhab lap,	80 + 50	0,27	0,27	0,26
		100 + 50	0,24	0,24	0,23
		120 + 50	0,22	0,22	0,21

* A hőátbocsátási tényezők számítása során figyelembe véve a pallóváz (10%) hőhíd-hatását

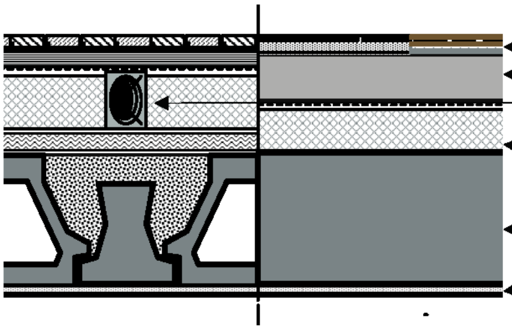
Padlásfödémek beton járóréteggel



Hőszigetelés		Hőszigetelő réteg vastagság (mm)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K) ha a járóréteg anyaga és vastagsága		
anyaga és terméktípusa	termékjele		kavicsbeton (min. 60 mm) λ = 1,28 W/mK	könnyűbeton habcement **100 mm** λ = 0,10 W/mK	könnyűbeton, hab cement **140**
Expandált polisztirol-hab **Üveggyapot** **Kőzet-gyapot**	**AUSTROTHERM** AT-N100 **NIKECELL** NC -100 **THERWOOLIN** tl-tt **TOPLAN** T **NOBASIL** MPN λ = 0,035 – 0,039 W/mK	100		0,24 – 0,26	0,22 – 0,24
		110		0,23 – 0,25	0,21 – 0,22
		120		0,22 – 0,23	0,20 – 0,21
		130		0,20 – 0,22	0,19 – 0,20
		140	0,23 – 0,26	0,19 – 0,21	0,18 – 0,19
		150	0,22 – 0,24	0,18 – 0,20	0,17 – 0,18
		160	0,21 – 0,23	0,17 – 0,19	0,16 – 0,17
		180	0,19 – 0,21	0,16 – 0,17	0,15 – 0,16
		200	0,17 – 0,19	0,15 – 0,16	0,14 – 0,15

Párafékező/záró réteg beépítésére a szerkezet páradiffúziós ellenőrzése alapján szükség lehet

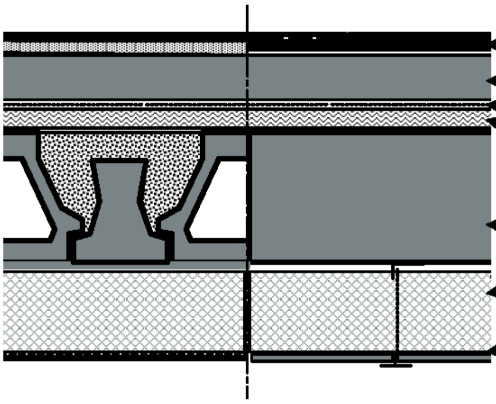
Pincefödémek szerkezeten belüli hőszigeteléssel



Hőszigetelés		Hőszigetelő réteg vastagsága (mm)	Rétegtervi átlagos hőátbocsátási tényező U (W/m^2K) ha a teherhordó szerkezet		
anyaga és terméktípusa	termékjele		Monolit vasbeton lemez-födémek	Egy. vb. gerendás és körüreges pallófödémek	Vázkerámia elemes födémek
Kőzetgyapot vagy **üveggyapot** filc vagy lap úsztatott párnafák között	**THERWOOLIN** LHF **ISOVER** UNIROLL **TOPLAN** NK **ROCKWOOL** ROLLROCK λ = 0,037 – 0,040 W/mK **	**40 + 20***		0,49 – 0,51	0,46 – 0,48
		50 + 20*	0,46 – 0,48	0,44 – 0,46	0,42 – 0,43
		60 + 20*	0,42 – 0,44	0,40 – 0,42	0,38 – 0,40
		80 + 20*	0,35 – 0,37	0,34 – 0,36	0,33 – 0,34
Kőzetgyapot, üveggyapot, vagy **expandált polisztirolhab** lapok úsztatott betonaljzat alatt	**THERWOOLIN** L-TK **ISOVER** TDPT **TOPLAN** T **AUSTROTHERM** AT-L **ROCKWOOL** RT-U **HERALAN** TP, TS λ = 0,033 – 0,045 W/mK	**50**		0,49 – 0,61	0,46 – 0,57
		60	0,45 – 0,56	0,43 – 0,54	0,41 – 0,51
		70	0,39 – 0,50	0,38 – 0,48	0,36 – 0,46
		80	0,35 – 0,45	0,34 – 0,44	0,33 – 0,41

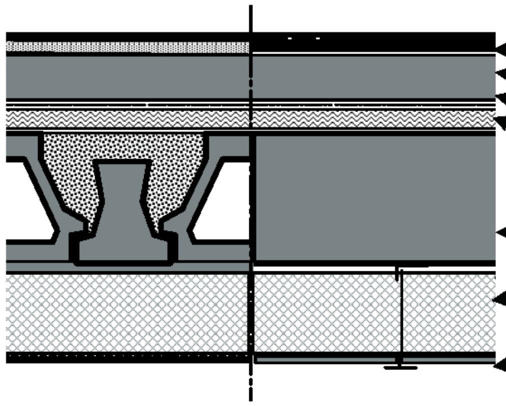
* Úsztatóréteg a párnafák alatt, teljes felületen: 20 mm vastagságú terhelhető kőzetgyapot lapokból ** Átlagos hővezetési tényező 10% fa (párnafák) és 90% hőszigetelő anyag számításba vételével

Pincefödémek alsó oldali hőszigeteléssel



Hőszigetelés		Hőszigetelő réteg vastagsága (mm)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K) ha a teherhordó szerkezet		
anyaga és terméktípusa	termékjele		Vasbeton lemezfödém	Egy. vasbeton gerendás/pallós födém	Vázkerámia elemes födém
Expandált polisztirolhab vagy **ásványgyapot** lapok ragasztással és /vagy mechanikai rögzítéssel	**AUSTROTHERM** AT-H80 **NIKECELL** LH **HERALAN** PTP **ROCKWOOL** MULTIROCK **ISOVER** KDP λ=0,035–0,040 W/mK	**40**			0,48-0,51
		60	0,42–0,45	0,41-0,44	0,39-0,42
		80	0,35–0,38	0,34-0,37	0,33-0,35
		100	0,30–0,32	0,29-0,32	0,28-0,31
		120	0,26–0,28	0,26-0,28	0,25-0,27
		140	0,23–0,25	0,23-0,25	0,22-0,24
Ásványgyapot lapok álmennyezet felett mechanikai rögzítéssel	**THERWOOLIN** HL **HERALAN** DP **ROCKWOOL** MULTIROCK **ISOVER** DOMO **TOPLAN** NT, NF λ=0,035–0,040 W/mK	**40**			0,48-0,51
		60	0,42–0,45	0,41-0,44	0,39-0,42
		80	0,35–0,38	0,34-0,37	0,33-0,35
		100	0,30–0,32	0,29-0,32	0,28-0,31
		120	0,26–0,28	0,26-0,28	0,25-0,27
		140	0,23–0,25	0,23-0,25	0,22-0,24

Árkádfödémek alsó oldali hőszigeteléssel



Hőszigetelés anyaga és terméktípusa	Hőszigetelés termékjele	Hőszigetelő réteg vastagsága (mm)	Rétegtervi átlagos hőátbocsátási tényező U (W/m²K), ha a teherhordó szerkezet vasbeton lemezfödém	egy. vasbeton gerendás/pallós födém	vázkerámia elemes födém
Expandált polisztirolhab vagy **ásványgyapot** lapok ragasztással és /vagy mechanikai rögzítéssel	**AUSTROTHERM** AT-H80 **NIKECELL** LH **HERALAN** PTP **ROCKWOOL** MULTIROCK **ISOVER** KDP λ=0,035–0,040 W/mK	140	0,23–0,26	0,23-0,25	0,22-0,25
		160	0,21–0,23	0,21-0,23	0,20-0,22
		180	0,19–0,21	0,19-0,21	0,18-0,20
		200	0,18–0,19	0,17-0,19	0,17-0,19
		220	0,16–0,18	0,16-0,18	0,16-0,17
Ásványgyapot lapok álmennyezet felett mechanikai rögzítéssel	**THERWOOLIN** HL **HERALAN** DP **ROCKWOOL** MULTIROCK **ISOVER** DOMO **TOPLAN** NT, NF λ=0,035–0,040 W/mK	140	0,23–0,26	0,23-0,25	0,22-0,25
		160	0,21–0,23	0,21-0,23	0,20-0,22
		180	0,19–0,21	0,19-0,21	0,18-0,20
		200	0,18–0,19	0,17-0,19	0,17-0,19
		220	0,16–0,18	0,16-0,18	0,16-0,17

Átlagos hővezetési tényező a rögzítő/függesztő elemek hőveszteség-növelő hatását figyelembe véve
Úsztatóréteg: 20 mm vastagságú terhelhető kőzetgyapot lapokból

Annex C: Specific Heat Loss Factor of the Building

Please note that the calculation of the specific heat loss factor of the building is part of the extended, detailed task only.

Having the composite structures on the external building envelope meet the required heat transfer coefficient **(U)** values does not mean that the **specific heat loss factor of the entire building ($q_{building}$)** also meets the requirements. The specific heat loss factor of the building depends on the **area / volume (A / V) ratio** of the building, the **ratio of the glazed and solid structures** on the envelope and the **ratio of the roofs, walls, slabs and transparent surfaces** of the building.

The **specific heat loss factor** of the building **($q_{building}$)** must meet the following requirement:

Area / Volume ratio (A / V)	Specific heat loss factor, $q_{building}$ [W/m^{3}K]
$A / V \leq 0{,}3$	$q_{building} \leq 0{,}2$
$0{,}3 \leq A / V \leq 1{,}3$	$q_{building} \leq 0{,}086 + 0{,}38 \cdot (\Sigma A / V)$
$A / V \geq 1{,}3$	$q_{building} \leq 0{,}58$

where:

- **A** is the sum of the area of the structures on the external building shell (please consider the surfaces of all structures that surround a heated internal space: exterior, ground, unheated spaces, neighbor buildings) **[m^2].**
- **V** is the volume of the heated spaces in the building **[m^3].**

The simplified calculation method to determine the specific heat loss factor of the building ($q_{building}$) is presented throughout the next chapters.

C.1. Determining the maximum allowed specific heat loss factor (q_{max})

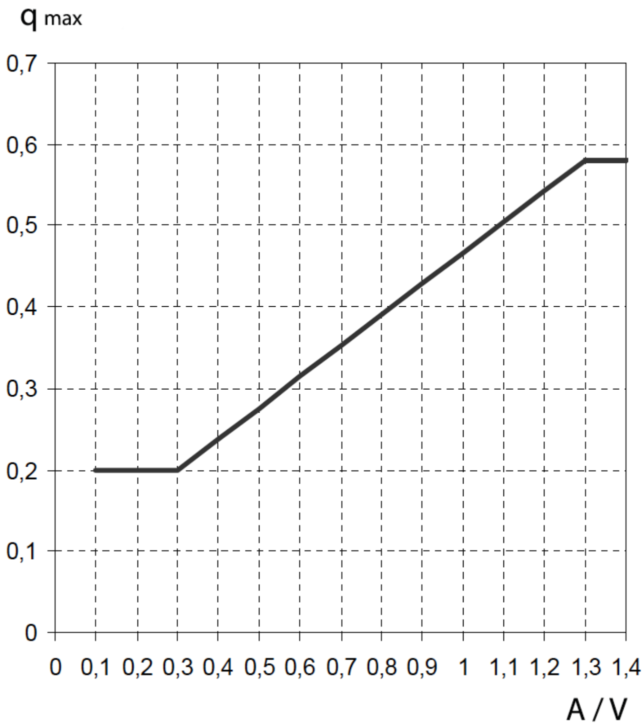
The maximum allowed value of the specific heat loss factor of the building (q_{max}) may be determined based on the actual **A / V** ratio of the building using the following formula:

$$q_{max} = 0{,}086 + 0{,}38 \cdot (A / V) \quad [W/m^3K]$$

Please note, that

- if the A / V ratio is $\leq 0{,}3$, then $q_{max} = 0{,}2$ or
- if the A / V ratio is $\geq 1{,}3$, then $q_{max} = 0{,}58$

The maximum allowed value of the specific heat loss factor of the building (q_{max}) may also be determined using the following graphic chart, once the actual A / V ratio is available.



Determining the maximum value of the specific heat loss factor based on the A/V ratio of the building

C.2. Calculating the actual value of specific heat loss factor ($q_{building}$)

The specific heat loss factor of the building ($q_{building}$) can be calculated using the following formula:

$$q_{building} = \frac{1}{V}\left(\sum AU + \sum l\Psi - \frac{Q_{sd} + Q_{sid}}{72}\right)$$

where:

- **V** is the volume of the heated spaces in the building **[m^3].**

- $\sum \boldsymbol{AU}$ is the sum of the area of building structures, **A [m^2]** multiplied by their corresponding heat transfer coefficient values, **U [W/m^{2}K].**
    - Please note that the **U** values may be reduced, if the structure is not exposed to the external air. Simplified **reduction factors** are:
    - Basement floor slabs: **0,5**
    - Attic floor slabs: **0,9.**

- $\sum \boldsymbol{l\Psi}$ expresses the heat losses caused by thermal bridges.
    - **l [m]** is the length of the thermal bridges, this can be determined by adding up the length of the edges of all those structures and structural junctions that considered a thermal bridge (perimeter of openings, length of cantilevers above openings, edges of loggias and terraces, external wall corners, etc.).
    - $\boldsymbol{\Psi}$ **[W/mK]** is the corresponding linear heat transfer coefficient. Using the simplified calculation method, we may neglect the linear heat transfer coefficient of the edges and use only the heat transfer coefficients of the composite structures instead. Using the **U value** of the structures a **correction factor** (χ) - expressing the effect of the linear thermal bridges - must be applied to the U values (please use the **Thermal Bridge Correction Factor** table, **C.2.1.** for the correction values. This ensures that the effect of the linear heat transfer is considered. *(Please note that according to the regulation, the linear heat transfer coefficient must be determined and used for slabs on ground and for basement walls. Please see* ***C.2.3.*** *for further details.)*

- $Q_{sd} + Q_{sid}$ expresses the passive solar gain of the building. The solar gain may be completely neglected when using a simplified calculation method.
    - Q_{sd} is the **direct solar radiation** received through glazed surfaces (windows, glazed walls, etc.), please see **C.2.4.**
    - Q_{sid} is the **indirect solar gain** provided by sunspaces, "winter gardens" and other passive solar systems (mass walls, transparent insulations, Trombe walls, etc.).

C.2.1. Thermal Bridge Correction Factors

This table lists the **χ correction factors** to be applied for the heat transfer coefficients (U values) when considering the effect of the thermal bridges.

Composite structures of the building envelope			**χ correction factor**
External walls (1)	External walls with external-, or uninterrupted internal thermal insulation	Low thermal bridge*	0,15
		Intermediate thermal bridge*	0,20
		Strong thermal bridge*	0,30
	Other external walls	Low thermal bridge*	0,25
		Intermediate thermal bridge*	0,30
		Strong thermal bridge*	0,40
Flat roofs (2)		Low thermal bridge*	0,10
		Intermediate thermal bridge*	0,15
		Strong thermal bridge*	0,20
Roofs and surrounding structures of attic - mansard or similar roof spaces (3)		Low thermal bridge*	0,10
		Intermediate thermal bridge*	0,15
		Strong thermal bridge*	0,20
Floors of attic- or mansard roof spaces (4)			0,10
Floors over open air spaces, arcade slabs (4)			0,10
Floors of basements (4)	Floors with internal thermal insulation		0,20
	Floors with thermal insulation beneath		0,10
Walls between heated and unheated spaces Walls of heated basements having external thermal insulation			0,05

χ correction factors to be applied for the U values when calculating linear heat losses

* To help to identify low- intermediate or strong thermal bridges please see the **C.2.2. Thermal Bridge Identification** table.

(1) Based on the specific **length** of external wall corners, RC or metal columns in external walls, protruding walls, perimeter of openings, internal walls or wall slab junctions to the external building envelop.
(2) Based on the specific **length** of the perimeter of the roof slab, specific **length** of attic walls, walls around skylight and external building structures on the roof.
(3) Based on the specific **length** of the perimeter of the roof slab, specific **length** of roof edges, connecting wall edges.
(4) Based on the specific **length** of the perimeter of the floor slab along the external walls.

C.2.2. Thermal Bridge Identification

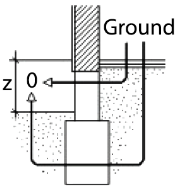
This table helps to determine if a wall or a roof structure has low- intermediate- or strong thermal bridge. This information is necessary to identify the most appropriate χ correction factor.

Composite structures of the building envelope	**Specific length of the thermal bridge (m/m^2)**		
	Classification of the building structure		
	Low thermal bridge	Intermediate thermal bridge	Strong thermal bridge
External walls	< 0,8	0,8 - 1,0	> 1,0
Flat roofs	< 0,2	0,2 - 0,3	> 0,3
Roofs and surrounding structures of attic-mansard or similar roof spaces	< 0,4	0,4 - 0,5	> 0,5

Identify thermal bridges to select the most appropriate χ correction factor

C.2.3. Linear Heat Transfer Coefficient Values of Slabs-on-ground or Basement Walls

Please use the following tables to determine the linear heat transfer coefficient of **slabs-on-ground** and for **basement walls**. The linear heat transfer coefficient for such walls must be determined even if using the simplified calculation method for the specific heat loss factor of the building.

	**Distance between the floor and the ground level z [m]**	**Thermal resistance of the slab structure around its perimeter** (considering 1,50 m width from the perimeter) $R = \frac{d}{\lambda}\ [m^2K/W]$							
		Not Insulated	0,20 - - 0,35	0,40 - - 0,55	0,60 - - 0,75	0,80 - - 1,00	1,05 - - 1,50	1,55 - - 2,00	2,05 - - 3,00
	-6,00	0	0	0	0	0	0	0	0
	-6,00 ... -4,05	0,20	0,20	0,15	0,15	0,15	0,15	0,15	0,15
	-4,00 ... -2,55	0,40	0,40	0,35	0,35	0,35	0,35	0,30	0,30
	-2,00 ... -1,85	0,60	0,55	0,55	0,50	0,50	0,50	0,45	0,40
	-1,80 ... -1,25	0,80	0,70	0,70	0,65	0,60	0,60	0,55	0,45
	-1,20 ... -0,75	1,00	0,90	0,85	0,80	0,75	0,70	0,65	0,55
	-0,70 ... -0,45	1,20	1,05	1,00	0,95	0,90	0,80	0,75	0,65
	-0,40 ... -0,25	1,40	1,20	1,10	1,05	1,00	0,90	0,80	0,70
	-0,20 ... +0,20	1,75	1,45	1,35	1,25	1,15	1,05	0,95	0,85
	0,25 ... 0,40	2,10	1,70	1,55	1,45	1,30	1,20	1,05	0,95
	0,45 ... 1,00	2,35	1,90	1,70	1,55	1,45	1,30	1,15	1,00
	1,05 ... 1,50	2,35	2,05	1,85	1,70	1,55	1,40	1,25	1,10

Linear heat transfer coefficient values of slabs-on-ground considering their length

Height of the wall next to ground or earth [m]	Heat transmission coefficients of the wall structure [W/m²K]								
	0,30 ... 0,39	0,40 ... 0,49	0,50 ... 0,64	0,65 ... 0,79	0,80 ... 0,99	1,00 ... 1,19	1,20 ... 1,49	1,50 ... 1,79	1,80 ... 2,20
... - 6,00	1,20	1,40	1,65	1,85	2,05	2,25	2,45	2,65	2,80
- 6,00 ... - 5,05	1,10	1,30	1,50	1,70	1,90	2,05	2,25	2,45	2,65
- 5,00 ... - 4,05	0,95	1,15	1,35	1,50	1,65	1,90	2,05	2,25	2,45
- 4,00 ... - 3,05	0,85	1,00	1,15	1,30	1,45	1,65	1,85	2,00	2,20
- 3,00 ... - 2,05	0,70	0,85	1,00	1,15	1,30	1,45	1,65	1,80	2,00
- 2,00 ... - 1,55	0,55	0,70	0,85	1,00	1,15	1,30	1,45	1,65	1,80
- 1,50 ... - 1,05	0,45	0,60	0,70	0,85	1,00	1,10	1,25	1,40	1,55
- 1,00 ... - 0,75	0,35	0,45	0,55	0,65	0,75	0,90	1,00	1,15	1,30
- 0,70 ... - 0,45	0,30	0,35	0,40	0,50	0,60	0,65	0,80	0,90	1,05
- 0,40 ... - 0,25	0,15	0,20	0,30	0,35	0,40	0,50	0,55	0,65	0,74
- 0,25 ...	0,10	0,10	0,15	0,20	0,25	0,30	0,35	0,45	0,45

Linear heat transfer coefficient values of basement slabs considering their length over the perimeter of the slab

C.2.4. Direct Solar Gain

The **direct solar radiation gain** (Q_{sd}) for the **entire heating period** (November 15 - March 15 in Hungary) can be calculated using the following formula:

$$Q_{sd} = \varepsilon \sum A_G \, g \, Q_{total} \; [kWh/a]$$

where:

- ε is a **utilization factor** that depends on the heat storage capacity of the building, please see C.2.5,
- A_G is the **area of the glazed surfaces** (not the area of the windows) [m²],
- **g** is the **unified solar factor** of all the glazing (this factor describes the percentage of the solar radiation that passes through the glass),
- Q_{total} is the **total solar gain throughout the heating period** [W]. Depending on the orientation of the glazed structures this value may be considered in Hungary as:
  - Northern orientation: Q_{total} = 100 W
  - Southern orientation: Q_{total} = 400 W
  - Eastern or Western orientation: Q_{total} = 200 W

C.2.5. Specific Heat Storage Capacity and Utilization Factor

The **heat storage capacity (M) of the building** is the sum of the heat storage capacity of all those structures that face the indoor building interior spaces, using the following formula:

$$M = \Sigma_j \Sigma_i \rho_{ij} d_{ij} A_j$$

The calculation must consider all skins of a composite structure till a specific thickness. This thickness is may be considered as the **smallest** of the following distances:

- 10 cm distance from the internal surface of the structure, or
- the distance measured from the internal surface of a skin till the first layer of thermal insulation, or
- the distance measured from the internal surface of a skin till the center of the structure.

The **specific heat storage capacity (m) of the building** is the ratio of the heat storage capacity (M) and the overall heated floor area (A) of the building:

$$m = M / A$$

- If **m ≥ 400 kg/m²**, then building is considered "**heavy**".
- If **m ≤ 400 kg/m²**, then building is considered "**light**".

Considering the structures of the external walls, roofs and floor slabs it is possible to decide about the main characteristics (heavy or light) of the specific heat storage of the building without calculation. If the building has RC or ceramic block walls and slabs it may be considered "heavy", etc. Please note however, that certain silicate block walls may belong to "light" structures; and that due to a thermal insulation on the internal surface may considerably reduce the heat storage capacity.

The values of the **utilization factor (ε)** may be considered as follows:

- **ε = 0,75** if the specific heat storage capacity (m) of the building is "**heavy**",
- **ε = 0,50** if the specific heat storage capacity (m) of the building is "**light**".

Annex D: Electric Power Demand of the Building

Please note that the detailed calculation of the electric power demand of the building is part of the extended, detailed task only.

The electric power demand of a building may be calculated using the following formula:

$$P_{building} = P_{residential\text{-}type\ units} + P_{non\text{-}residential}\ [kW]$$

Electric power demand of residential-type units

The electric power consumption of **residential units** or **residential-type units** (flats in a residential complex, hotel rooms in a hotel, hospital rooms in a hospital, etc.) can be calculated using the following formula, **if the number of such units is more than 15** (if there are less units, please use the "non-residential" calculation method):

$$P_{residential\text{-}type\ units} = e_{unit} \cdot n \cdot P_{unit}\ [kW]$$

where

n is the number of the residential-type units (should be more than 15).

P_{unit} [kW] is the electrical power demand of the unit:

- if the unit has electric cooker: **11,04 kW,**
- if the unit does not have electric cooker: **6,9 kW,**
- if the unit is a hotel or hospital room: **2,3 kW,**

e_{unit} is the simultaneity coefficient (this reduces the power-demand because that not all electric devices are typically used simultaneously):

$$e_{unit} = 0{,}2 + \frac{0{,}8}{\sqrt{n}}$$

Please note that the power consumption of the "**non-residential**" parts of the building must also be considered and added up to determine the overall power consumption of the building.

Electric power demand of "non-residential" buildings

For a more accurate calculation you may use the following formula to calculate the electric the power required for lighting, for the building systems and services and for the equipment:

$$P_{non\text{-}residential} = e \cdot (\Sigma P_{lighting} + \Sigma P_{HVAC} + \Sigma P_{technology})\ [kW]$$

Electric power demand: lighting, building systems and equipment

where

e is the simultaneity coefficient (**0,6 ≤ e ≤ 1,0**): please review with consultant!

Σ P $_{lighting}$ [kW] is the sum of the electrical power demand of artificial lighting based on the sum of the total floor area of the corresponding functions:

- **5 W/m²** (low visual demand) required for storages, WC, machinery rooms, etc.
- **10 W/m²** (intermediate visual demand) required for passages, corridors, reception, restaurant, halls, etc.
- **15 W/m²** (mediate visual demand) required for offices, workshops, kitchens, etc.

Σ P$_{HVAC}$ [kW] is the sum of the electrical power demand of the building services systems, such as heating, ventilation, air-conditioning units, etc.

Σ P $_{technology}$ [kW] is the sum of the electrical power demand of all electric devices and equipment including: elevators, computers, microwave and hair-drier equipment, security-systems, etc.

The following tables lists some of the typical electric power demand of devices and equipment (**P $_{technology}$**). You may use these values and add project specific devices elements if necessary.

Buffet and tea-kitchen

Electric equipment	P_n [kW]
Coffee and tea maker	0,7 – 1,2
Microwave oven	0,5 – 2,0
Cattle	2,0 – 2,5
Fridge	0,2
Deep freezer	0,5

Electric equipment	P_n [kW]
Grill	0,7 – 1,0
Toaster	0,8 – 1,6
Turmix machine	0,4
Air exhauster	0,2 – 0,3

Generic kitchen

Electric equipment	P_n [kW]
Dishwasher	3,5 – 5,0
Kitchen robot machine	0,2 – 0,6
Meat grinder	1,0

Electric equipment	P_n [kW]
Freezer	0,2
Grill	0,8 – 3,3
Other equipment	2,0 – 3,0

Industrial kitchen

Electric equipment	P_n [kW]
Electric cooker	5,0 – 12,0
Electric boiler	12,0
Freezer	0,5
Freezer cupboard	0,8 – 1,2

Electric equipment	P_n [kW]
Dishwasher	3,0 – 8,0
Electric fryer	5,0
Dishwasher	3,0 – 8,0
Other equipment	3,0 – 6,0

Elevators, escalators

Electric equipment	P_n [kW]
Hydraulic elevator (max. 30 m), residential building	7,0 – 28,0
Hydraulic elevator (max. 30 m) public building	10,0 – 75,0
Wire-suspended elevator (max. 30 m) residential building	2,0 – 8,0
Wire-suspended elevator (max. 30 m) public building	3,0 – 25,0
Wire-suspended elevator without machinery room (max. 9 m)	2,2
Elevator without machinery room (max. 9 m)	1,1
Small industrial elevator (250 kg)	1,2 – 1,5
Panorama elevator (1250 kg)	25 – 31,0
Industrial elevator (2000 kg)	5,0 – 7,0
Escalator (max. 40 m)	7,0 – 90,0
Escalator (max. 150 m)	5,0 – 20,0
Hospital elevator (2500 kg)	6,0 – 8,0

Doctors' examination room

Electric equipment	P_n [kW]
Dentist chair	0,2 – 0,5
Hand and gloves cleaner	0,02
Light therapy equipment	0,1 – 0,2
Water cleaner	0,05

Electric equipment	P_n [kW]
Dentist's X-Ray	2,0
Mobile X-Ray	13 - 15
X-Ray viewer	0,05

Hospital

Electric equipment	P_n [kW]
Surgeon small equipment	0,7 – 0,8
Labor equipment	0,1 – 1,2
Diagnostic X-Ray	55,0

Electric equipment	P_n [kW]
Lab drier	0,5 – 1,0
Air handling devices	0,1 – 0,2
Surgeon equipment	8 – 10,0

Swimming pool

Electric equipment	P_n [kW]
Hydro-pool (3-5 persons)	2,5 - 6,0
Hydro-pool (6-8 persons)	6,5 - 8,5
Hydro-pool with heater	+3,0 - 5,0
Solarium	9,0 - 11,0

Electric equipment	P_n [kW]
Sauna (3-5 persons)	4,5
Sauna (8-12 persons)	22,0
Sauna with heat-sinker	6,0
Infra sauna	1,5 - 2,5
Finnish-sauna (2-3 persons)	3,0

Other equipment

Electric equipment	P_n [kW]
Washing machine	2,2 – 3,3
Washing machine with drier	3,3
Drier	2,1 – 3,3

Electric equipment	P_n [kW]
Sewing machine	0,1 – 2,0
Hair drier	0,4 – 2,0
Vacuum cleaner	0,2 – 1,6

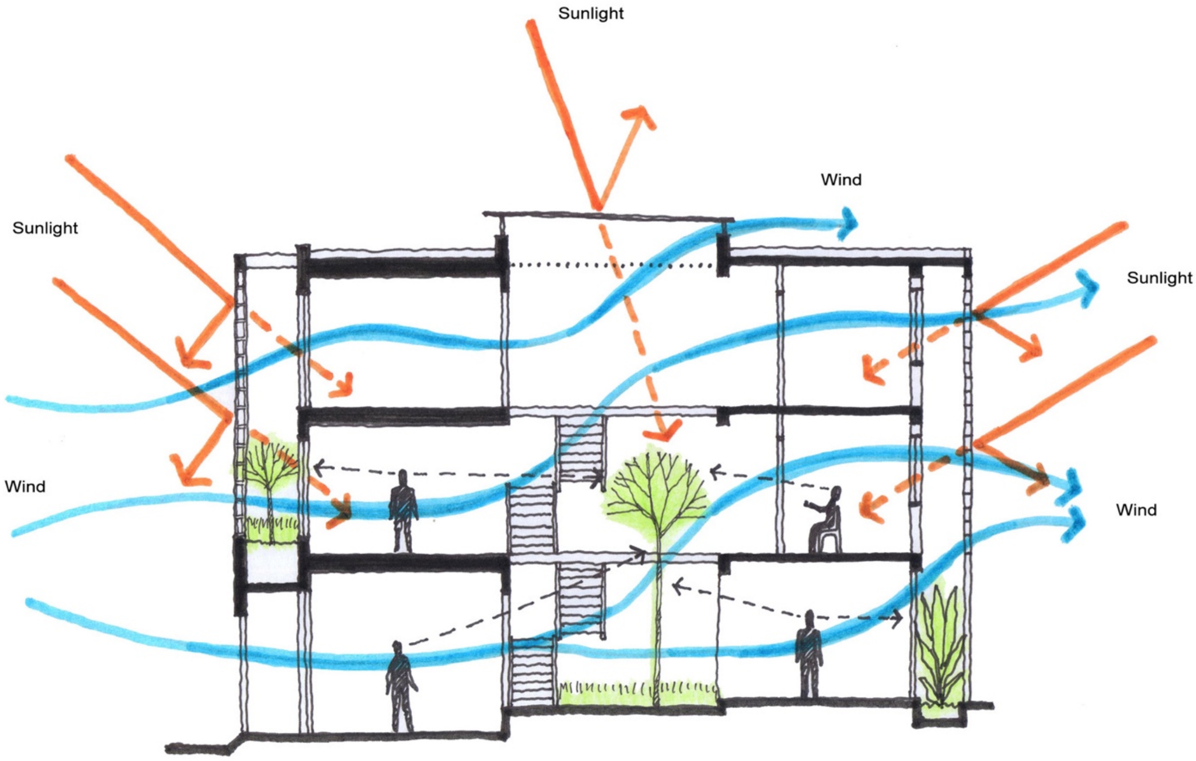
Office and IT equipment

Electric equipment	P_n [kW]
Smoke, fire alarm and similar systems (smoke, fire, security, etc.)	0,5-5,0
Consumer electronic devices (TV, video, CD/DVD-players, speakers, etc.)	0,1-10,0
Security systems	0,5-2,5
Projectors	0,2-0,6
Computer systems (computer, scanner, printer, etc.)	0,6 – 1,2

Building Energetics and Services

COMPLEX 1 & DIPLOMA

Booklet Example



To help your work to create the required A4 sized "*Building Energetics and Services*" booklet, please consider the guidelines and examples of this Annex.

Booklet Example and Requirements

1. Title, Program and Design Overview

the main title of this booklet should be "**Building Energetics and Services**", please also include the following - usual - information on the title page:

- Your name, Neptune code and year
- Title of the design project you work on
- Date of submission
- You may also add a logo or an image of your design

Please also include **one page description** of your **design project**, summarizing the program, your design intentions, considerations, etc. Typically, the same summary is required for all other booklets as well to provide a brief project design overview for the reader.

2. Building Utilities and Services

This chapter of your booklet should **list the available and planned utilities** and services of your building site using various line types, colors and a legend, as described in the corresponding chapter of this aid. You may create the site plan as part of the architectural design documentation set using the appropriate scale. Please include a "**small" overview of the site-plan** in the booklet as well (regardless of the scale and colors).

3. Heating

In this chapter please explain the **heating system(s)** you wish to apply. Define - estimate or calculate - the size of the necessary boiler rooms or plants (heating plant, gas boiler plant, solid fuel boiler plant, etc.) supported by the estimated heating performance of your design.

Clarify **if you will have gas supply** in your building. If you will have gas, please explain where and how will you position the gas meter(s). Define the necessary **gas meter box or cabinet size** or declare if you need a gas meter **room**. Define the necessary floor area, headroom based on estimated gas demand - estimated or calculated - and indicate this on the architectural floor plan as well.

Define if you need an **explosion relief surface** and if you need, please validate its required size and indicate it in the architectural design as well.

Explain if you need any **chimneys**, define their length and location and indicate these in the architectural design documentation as well.

4. Domestic Hot Water Production

In this chapter please clarify if you need or do not need a **Domestic Hot Water Plant**. If you do need, please decide about its location in the design and indicate this on the architectural floor plan as well.

Present if you need or do not need a **Water Booster Plant**. If you do need such plant, clarify the necessary floor area and location in the building supported by the estimated or calculated water demand of your project. Please indicate this on the architectural floor plan as well. You may also select a manufacturer-specific pressure booster, and mention it in this chapter, you may include a drawing or a photo from the manufacturer's website or brochure.

5. Ventilation

In this chapter please explain if you need **artificial ventilation** in your building, identify the spaces and functions where its required or planned. Explain what sort of ventilation space will you provide according to the type of ventilation units or ventilation system. Please support your design decision by the necessary - estimated or calculated - air change values. Define the necessary floor area, headroom based on estimated gas demand and indicate this on the architectural floor plan as well. You may include a drawing or a photo from the manufacturer's website or brochure.

6. Electric Power Supply

Describe the available **Electric Power Grid Infrastructure** of your site and define the available surplus power capacity based on the environment. Define - estimate or calculate - the **total electric power demand** of your building, and create the necessary electric switch cabinet or room sizes as well as their location in the building. Declare if you need a **transformer station** and if yes, design its size and location as well.

Decide about **backup and emergency power supply** necessities, their power demand and required room and space characteristics to locate these in your building. You may include a drawing or a photo from the manufacturer's website or brochure.

Decide about the selected **renewable energy systems** in your building, list these systems indicate their position in the building and estimate their production characteristics. You may include a drawing or a photo from the manufacturer's website or brochure.

Decide about the necessary **elevator types and required rooms** in your design. Make sure that the manufacturer specific regulations and requirements are met. You may include a drawing or a photo from the manufacturer's website or brochure.

7. Building Energy Performance

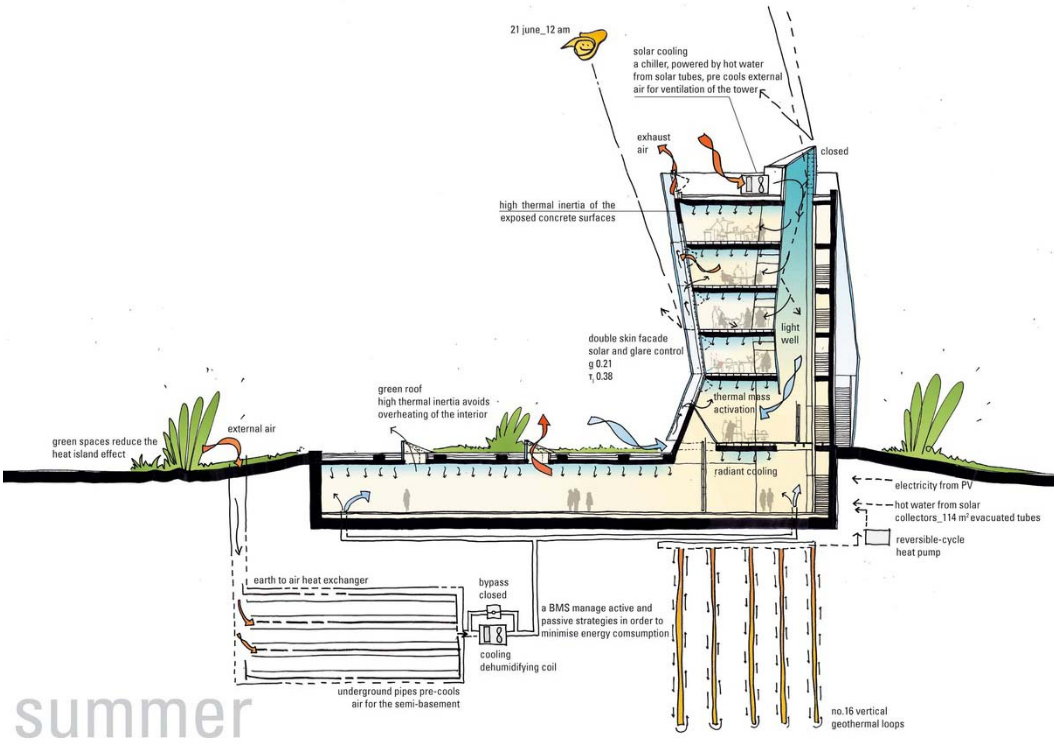
Please estimate the **annual primer, energy (E_p)** demand of your building and compare this to the **maximum allowed** value **(E_r)** described by the regulations. Make a simplified **Building Energy Performance Classification** calculation by **determining** the energy **classification class** of your design.

Classification classes		Ratio [%]	Classifications
A+	A+	< 55	Very energy efficient
A	A	56 - 75	Energy efficient
B	B	76 - 95	Better than requirement
C	C	**96 - 100**	**According to requirement**
D	D	101 - 120	Close to requirement
E	E	121 - 150	Better than average
F	F	151 - 190	Average
G	G	191 - 250	Close to average
H	H	251 - 340	Weak
I	I	341 >	Bad

Building Energy Performance classification diagram example

8. Renewable Energy Operations

Please prepare a list of **applied renewable technologies** and briefly describe their application requirements in the actual building design. Draft **energy operation schemes,** using min. A5 size schematic drawing. Displaying the hot- and the cold seasons operation characteristics during day and night.



Example sketch of the energy operation scheme during the day of the hot season