RAUM-K
New World of Energy

Ceiling storage tank

RAUM-K BUFFER

powered by

singular
klima to go

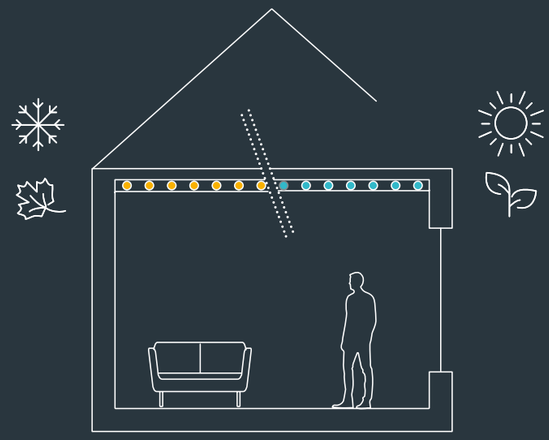
Why Raum-K?

Raum-K is the heating and energy system of the future. "Old" energy sources that generate heat from fossil fuels, belong in the past. We, as energy provider of the future, for more than 20 years, have been dealing with healthy, resource-saving and renewable energy, which is used to benefit people, the environment and the preservation of our habitats. We see ourselves as transmitters and receiver, an energy carrier and multiplier for the energy and heating revolution of the present and the future.

The sun is our role model: Raum-K – New World of Energy

CONTENT

POTENTIAL OF A CLIMATE CEILING



Combined heating and cooling

Heat pumps are increasingly being employed: already more than 50 %* of new buildings use them for the efficient operation of their surface heating. In residential buildings, the pumps mainly generate heat for underfloor heating - leaving their cooling potential unused.

A CLIMATE-CONTROLLED CEILING CAN DO BOTH: HEATING AND COOLING.

Many rooms have drafts and cold air constantly flows through them. Rooms with such deficiencies are very common. In comparison, air conditioning systems can cool more strongly, but often cause uncomfortably cold draughts with high energy expenditure. Fortunately, air-conditioning ceilings have now become established as a means of air-conditioning. These offer practical advantages for a wide range of applications, such as absolutely silent cooling without unpleasant draughts.

A low-cost, energy-saving mini-ventilation system guarantees hygienic air exchange. This system can cool down lower due to the integrated dehumidification. The investment is similar to air conditioning system but the comfort increases, while the operating factor costs decrease.

Comfortable warmth without heating air

Do you know the pleasant feeling of being warmed by the sun on a clear winter day? The air is cool, but the radiant heat makes up for it.

Heating with the mineral climate ceiling also works according to this principle. All surfaces in the room are heated, radiating this heat to us. The heating power can be reduced. Therefore, we are surrounded by gently heated surfaces. This means that the air does not have to be overheated and thus dried out - we feel good all round.

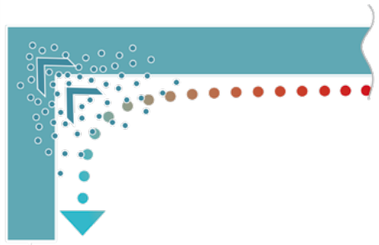
* Status: 2021

Healthy breathing air

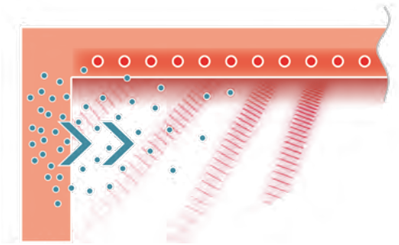
A person breathes 24,000 times every day. That is up to 12,000 litres of air* that flows into our lungs - including all the substances suspended in it. Among them is mainly house dust, which consists of mite excrement and other organic components. Allergy sufferers in particular know the value of a low-dust room climate. With a climate ceiling based on radiant heat, people can breathe cleaner air, because it circulates less dust during heating than systems based on convection.

Against mould and moisture

Mould is more than unpleasant and dangerous for people and buildings. Low ventilation increases the risk of harmful mould growth. Climatic ceilings actively prevent mould growth, because they primarily warm the room envelope - not the air. If the walls are warmer than the air, they remain dry and do not provide a breeding ground for mould.



If the air is warmer than the enveloping surfaces it cools down on them. Moisture in the air condenses on and penetrates the walls.

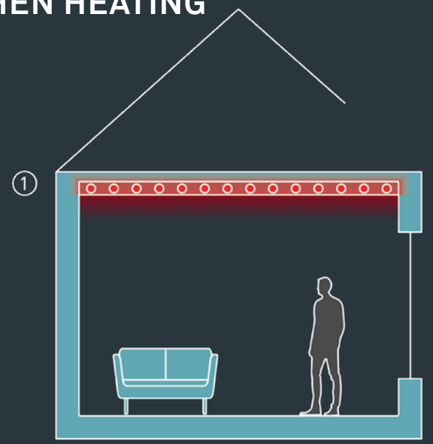


If the air is colder than the enveloping surfaces, it warms up on them. In the process, it evaporates water: the masonry dries.

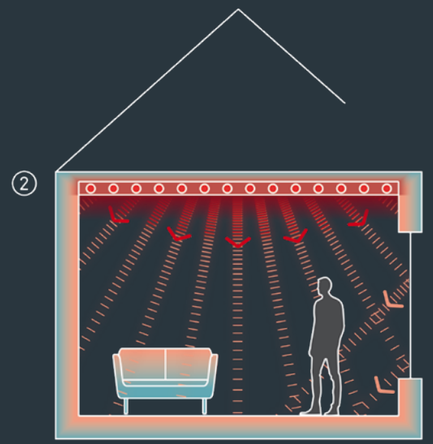
* R. F. Schmidt, G. Thews, Physiologie des Menschen, Springer, Berlin, 1995

HOW A CLIMATE CEILING WORKS

WHEN HEATING



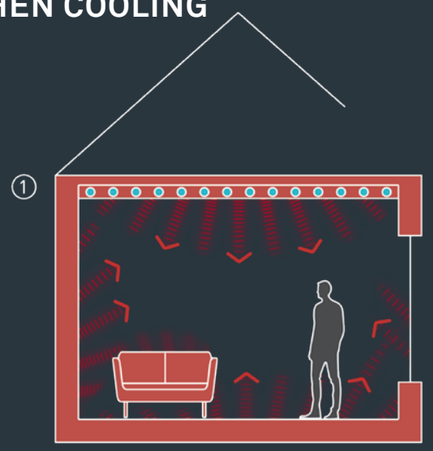
Warm water flows through pipes in the ceiling and heats its surface. On the warm surface of the ceiling, the air temperature rises.



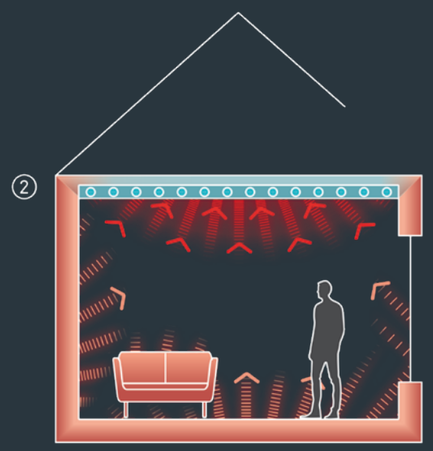
The warm air can neither rise nor cool on the ceiling: Convection is slowed down. Heat is only transferred to the floor, walls and furniture by radiation.

All surfaces are now warmer than the air in the room. Like the ceiling, they radiate their heat gently and evenly into the room.

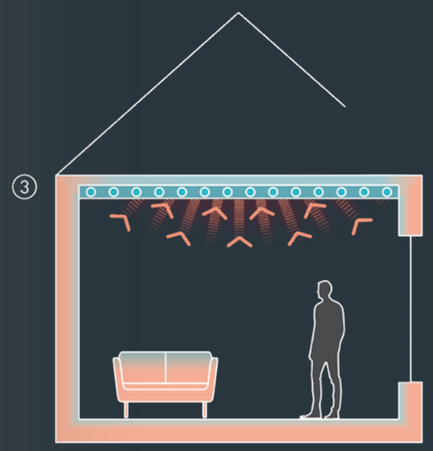
WHEN COOLING



If the surfaces are heated up in summer they radiate a lot of heat into the room. Cold water will flow through the pipes of the climate control ceiling to cool the ceiling surface.



The cooled ceiling surface absorbs heat radiation from the room. It permanently dissipates this heat with its cooling water. The radiation exchange between the cool ceiling and the warm surfaces now also cools the walls, floor and furniture.



The cooled surfaces radiate less heat into the room and allow the body a comfortable heat regulation again without sweating. This is because the body also releases its excess heat to cooler surfaces through the exchange of radiation.

Radiant heating

A climate-controlled ceiling brings heat into the room mostly by emitting thermal radiation. As a result it primarily heats the surfaces: Ceiling, wall, floor and furniture become warmer than the air. The warmer the surfaces are, the more heat they themselves radiate to their surroundings.

The pure heat radiation of the climate ceiling transforms virtually every surface of the room into a warm surface. The air on the other hand, remains pleasantly fresh and is not overheated. This ambient climate is extremely comfortable for people.

Radiant cooling

Due to direct sunlight and industrial heat, the walls and floor can heat up considerably in summer. These overheated surfaces radiate heat which disturbs the natural heat regulation of humans.

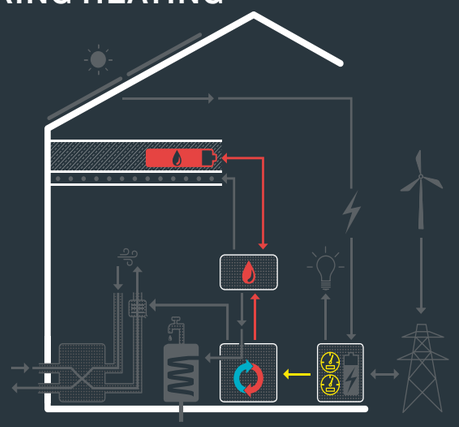
This is why cooling is achieved with the help of the ceiling: All overheated surfaces now transfer their heat via radiation exchange to the cooler climate ceiling, where it is continuously dissipated with the cooling water. In the process, the surfaces cool down and radiate correspondingly less heat into the room. In exchange we can radiate our own excess heat back to the cooler environment and feel more comfortable.

The air-conditioned ceiling is supplemented by controlled ventilation of the living space: this dehumidifies the air during hygienic air exchange and therefore enables air-conditioning to a high intensity.

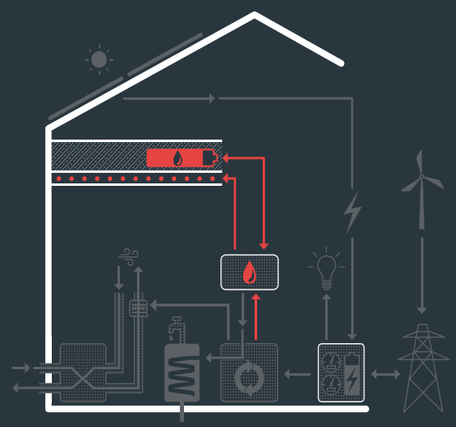
UNIVERSAL INGENIOUS
ADVANTAGES OF A CEILING STORAGE

The system can also be supported or operated with a solar thermal system, provided that the location and structural conditions are appropriate.
The storage temperature can exceed 40°C without overheating the rooms. At the same time, water temperature of less than 25°C can be adequate. Ideal conditions for a "solar active house".

DURING HEATING

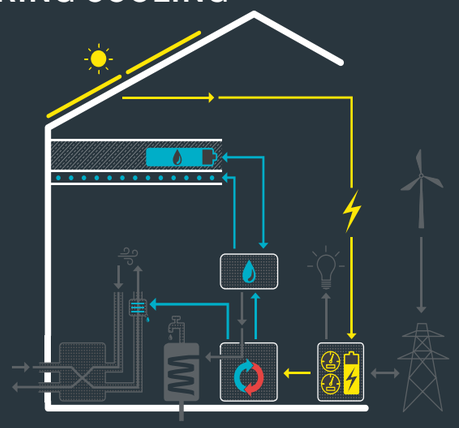


In heating mode, the heat pump converts excess electricity into heat. The heat is stored in the insulated concrete core of the storey ceiling.

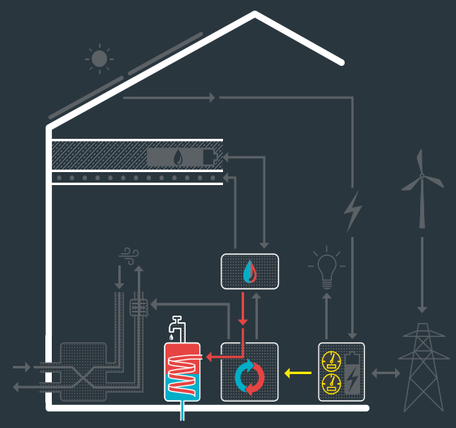


Passively escaping heat covers a base load during heating. Actively extracted heat smoothes out peak loads. The heating system can thereby be dimensioned more economically and the heat pump achieves a higher efficiency.

DURING COOLING



In summer, the heat pump converts excess electricity into cold. The cold is stored in the insulated concrete core of the storey ceiling. In addition, the heat pump removes heat from the building and generates cooling for the air-conditioning ceiling, ceiling storage and ventilation system.



The waste heat from the air-conditioning ceiling and the heat pump is used to heat the domestic hot water during cooling operation. The ventilation system cools and dehumidifies the air flow during cooling mode. The cooling output is increased and condensation minimised by means of registers.

Self-consumption pays off

A PV system pays off most when the generated energy is completely consumed on site. Every kilowatt hour of electricity that is fed into the public grid and later drawn back from it generates additional costs.

That is why it is important to be able to store the excess energy of the high-yield hours until it is needed. Up to now, battery storage systems have mainly been used for this purpose. There is another much cheaper solution: the Raum-K Buffer ceiling storage system.

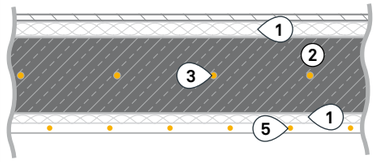
Store heat and cold in the ceiling

Instead of charging a large battery storage system with electricity, the energy can also be stored in the form of heat or cold in the solid ceilings of the building. As with building component activation, pipe coils are integrated into the concrete core of the ceilings for this purpose. As an alternative, existing concrete ceilings can be utilised for as energy storage by installing pipes with heat conduction profiles under the ceiling.

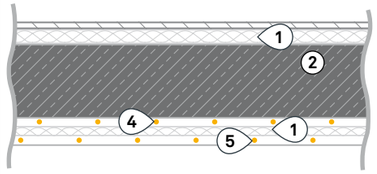
If a surplus of energy is now produced in winter, water is heated with it and fed through the pipes of the ceiling storage tank. In this way, the concrete can absorb large amounts of thermal energy and store it for later use. When the demand for heating occurs, the heat is taken from the ceiling storage tank again via the pipe regulators.

To prevent the heat from escaping out of control in the meantime, the concrete storage tank is insulated. The heat which still penetrates the room through the insulation is precisely calculated and intentional: this heat flow helps to cover the base load in the room - passively, without using the circulation pumps. This lowers the energy requirement. If the relief provided by the ceiling storage tank is optimally included in the planning, the system technology can usually be designed to be 50 % more economical.

It should be noted that, all this does not only apply to heating: when cooling is required in summer, the excess energy is simply stored as cold in the concrete.



Integrated ceiling storage* with climate ceiling



Retrofitted ceiling storage* with
Air-conditioned ceiling

Structure

1 Insulation level
2 Concrete ceiling
3 Storage register in the concrete core
4 Storage tank register retrofitting
5 Climatic ceiling

* Patent pending

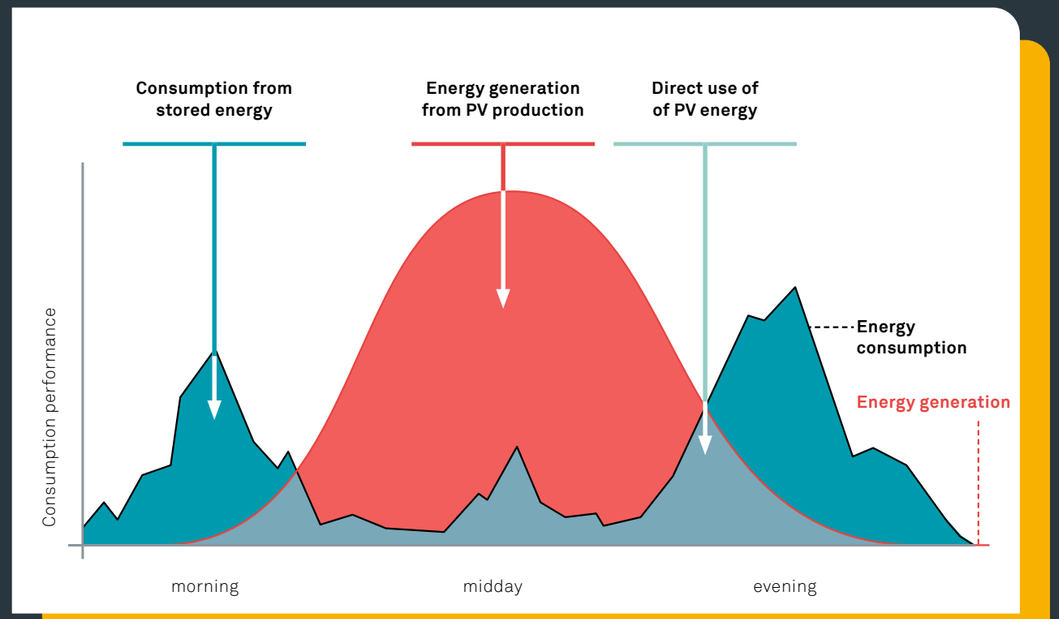
POTENTIAL AND SYNERGY

What does 360 kWh storage capacity mean?

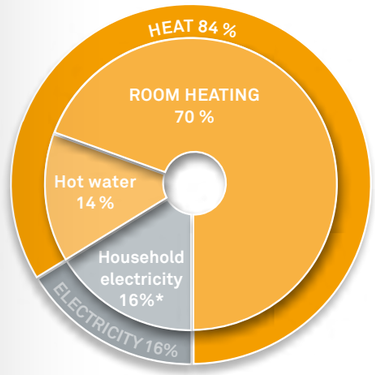
In a building with 120 m² of living space and a ceiling thickness of 0.22 m, a fully installed ceiling storage tank stores around 360 kWh of heat. Depending on the insulation and outside temperature, this building can be heated for several days with a charged storage tank without generating new heat. In the Fraunhofer research project "Wind Heating 2.0", for example, a duration of 10 days was achieved.

Nevertheless, it is recommended not to activate the heat pump only when needed, but to constantly generate a little additional heat or cold. This makes it possible to significantly increase the system's efficiency: hardly any electricity is needed for the heat pump and a photovoltaic system can still cover a good portion of this low demand even in winter.

As the diagram shows, PV systems generate a surplus of electricity almost every day: this allows the heat pump to be operated constantly at high efficiency and the thermal energy to be stored in the ceiling until needed. This secures the supply over several shady days and increases the efficiency of the room climate system.



Energy consumption of a building with 120 m² area over the course of a day



Source: Working Group on Energy Balances, summary of application balances for the final energy sectors 2013 to 2016, as of 01/2018

* Household electricity = lighting, information / communication technology, mechanical energy, other process cooling / heating, air conditioning cooling

Battery and ceiling storage in strong symbiosis

Battery storage makes sense - it permanently increases the yield of a PV system and reduces the electricity costs to the residents. The disadvantage: they are expensive to purchase and the production and disposal of batteries is harmful to the environment. With overhead storage, the same efficiency is achieved with the same storage volume for a fraction of the cost.

Raum-K recommends the use of a smaller battery storage system for the household electricity needs. The remaining energy demand can be buffered as heat or cold in the solid ceilings much more cost-effectively than in battery storage, as the large storage volume of the storey ceiling component can be put to good use there.

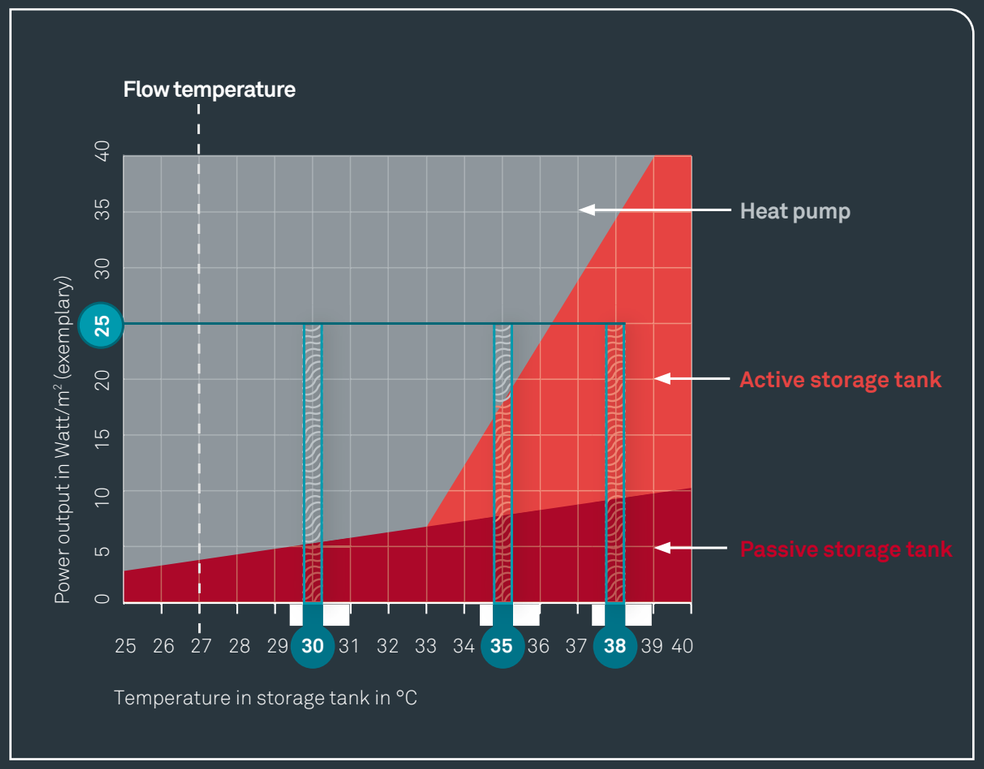
In German households, heat accounts for more than two thirds of the energy demand. Therefore, it is not absolutely necessary to store surplus energy in the form of electricity. Converting surplus electricity into heat or cold and buffering it in the ceiling is much more efficient, because it can cover up to 84 % of a household's energy needs!

Profiting from grid oversupply with clever energy management

When the weather is very windy, a surplus of renewable electricity is usually produced. This electricity must also be collected so that the grid is not overloaded. If the demand for it is too low, the electricity is traded at a lower price. Sometimes it can even happen that the consumption is compensated: At peak times, the purchase of a megawatt hour of electricity was already compensated with over 60 €.

A residential complex with overhead storage could buffer several megawatt hours. A large storage volume therefore pays off in order to store energy when it is particularly affordable or even yields a profit. Moreover, it makes more ecological sense to use excess energy for later heating and cooling than to let it go to waste.

IMPACT



The passive storage

The special feature of Raum-K Buffer is the unique combination of surface temperature control and ceiling storage in one and the same component: the air-conditioned ceiling. The waste heat from the ceiling storage unit therefore passively supports the heating system and is not lost unused. The warmer the ceiling storage unit is, the more heat penetrates into the room - and the same applies to the stored cold during cooling operation.

The passive heat flow of the ceiling storage tank is precisely calculated and included in the design of the heating and cooling performance. It permanently covers a base load, increases the efficiency of the heat pump and does not require any pump electricity. Energy cannot be used more efficiently. The passive effect of the storage tank is maintained for as long as possible. Only when a sufficient surplus has already been stored is energy actively withdrawn.

The system can also be supported or operated with a solar thermal system, provided that the location and structural conditions are appropriate. The storage temperature can exceed 40 °C without overheating the rooms. At the same time, a heated water temperature of less than 25 °C can be sufficient. Ideal conditions for a "solar active house".

The active storage

If the passive effect of the storage tank is sufficiently guaranteed, heat is also actively extracted from the storage tank if required and conducted through the ceiling for heating. In the object from the Raum-K cost comparison, the temperature range of 33 to 40 °C is freely available for this application. This reduces the load on the heat pump and covers peak loads without the need for large-scale system technology.

The use of the heat pump

1. Storage tank: The heat pump fills the ceiling storage tank whenever an excess of electricity is available. This can happen when the yield of the PV system exceeds the current demand or when the electricity price is particularly low.

2. Support heating-cooling operation: The heating and cooling demand is mainly covered by the ceiling storage tank. If the storage tank alone is no longer sufficient, the heat pump provides the additional power.

3. The heat pump is operated during the daytime hours (8:30 to 16:30) as much as possible. At this time, the temperatures are on average 10K higher than at night. This increases the system efficiency by approx. 20 %.

CALCULATION EXAMPLE RAUM-K BUFFER ENERGY STORAGE

Thermally active thickness of the ceiling storage	0.24 m
Area of total ceiling storage	1,965 m²
Active storage capacity building (Δt 7 K)	2,070 kWh
Total storage capacity Building (Δt 20 K)	4,225 kWh
Ceiling storage: Cost per kWh Storage capacity	36 €
For comparison Battery storage (lithium-ion): Cost per kWh Storage capacity	800 – 1,800 €

General conditions

The calculation example refers to a building with a ceiling area of 2,000 m² and a 24 cm thick ceiling storage in the concrete core. Heat can be buffered in this ceiling storage until the concrete reaches 40 °C. Higher temperatures require additional constructional measures due to expansion.

Up to a temperature of 33 °C, the heat is stored and contributes passively to efficient heating. In the temperature range from 33 °C to 40 °C, heat is actively extracted from the ceiling storage tank as needed to maintain a supply temperature of 27 °C for the climate-controlled ceiling.

The storage capacity of the entire 2,000 m² under these conditions is over 4000 kWh. That is around two kilowatt hours per square metre of storage area. Of this, one kilowatt hour is used passively and one kilowatt hour actively.

Cost comparison of battery and ceiling storage

The construction costs for 2,000 m² of ceiling storage, including piping, circulation pumps and control technology, amount to approximately 75,000 €. This amount corresponds to about 18 € per kilowatt hour of storage capacity or 36 € if the active storage is taken into account. By comparison, the actively usable kilowatt hour of a battery storage system costs between €800 and €1,800, including technology and installation - this does not include space costs! Depending on the storage requirements, only part of the ceiling can be designed as a storage unit.

System technology and follow-up costs

If possible, the system technology should be designed to cover the peak loads on cold days. Usually, the heat generators are sized accordingly. However, since the ceiling storage tank permanently covers part of the heating load, the heat generator only has to cover the difference to the peak load. This is why the system technology can be up to 70 % smaller and more cost-effective when optimally designed. This saves costs in the long term, far beyond the purchase price, since smaller systems mean lower operating and maintenance costs.
While a battery storage system has to be replaced every 10 to 20 years, an overhead storage system stores heat and cold for as long as the building remains standing.

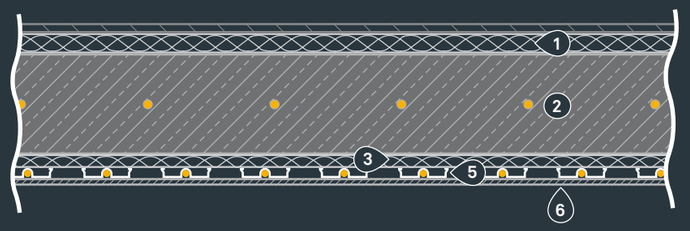
Ceiling storage in cooling mode

In summer, excess electricity from photovoltaics is converted into cooling energy by the heat pump and stored in the ceiling storage tank. The interaction of the passive and active storage adapts the temperature ranges of the flow temperatures of the cooling mode, similar to the heating mode.
The principle of surface air conditioning provides the best possible efficiency and effectively reduces energy costs.

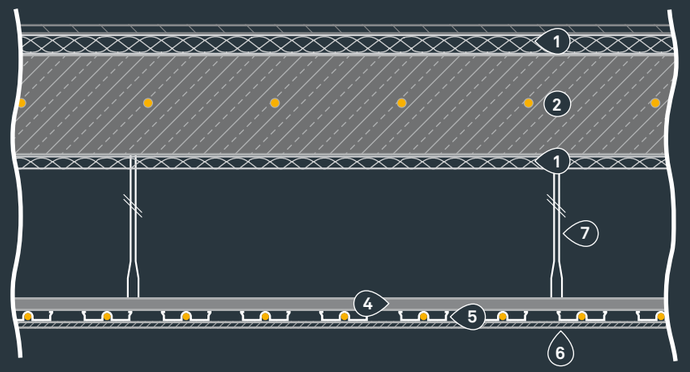
DESIGNS

NEW CONSTRUCTION

Integrated ceiling storage tank with directly mounted Raum-K Flex climate-controlled ceiling



Integrated ceiling storage tank with suspended air-conditioned ceiling

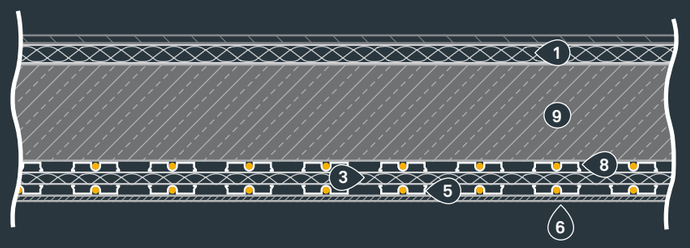


Structure

1 Insulation
2 Concrete ceiling storage
3 Insulation level with support profile
4 Support profile
5 Heat conducting profile with pipe register
6 Suspended ceiling: gypsum plasterboard or gypsum fibreboard optionally with fire protection
7 Suspension as desired
8 Activation level ceiling storage: heat-conducting profile with pipe register
9 Concrete ceiling

REFURBISHMENT

Retrospectively installed ceiling storage with Raum-K Flex air-conditioned ceiling



Heat-conducting profiles with pipes can be mounted on an existing concrete ceiling in order to activate it as a ceiling radiator. Underneath, an insulation level is installed that is combined with support profiles. The heat-conducting profiles for the Raum-K Flex climate-controlled ceiling are suspended in these support profiles and finally everything is cladded with standard drywall panels.

THE OVERALL SYSTEM FOR A HEALTHY INDOOR CLIMATE

NEW CONSTRUCTION

Integrated in solid ceilings

In new buildings, the pipelines for activating the ceiling storage are integrated directly into the concrete core of the solid corners. Depending on the ceiling system, this is done during prefabrication in the production or during concreting on site. Finally, an insulation layer is installed under the activated ceiling.

The Raum-K Flex climate-controlled ceiling can now be installed under this construction. The technical drawings in cross-section show the possible combinations with the Raum-K Flex climate-controlled ceiling: as direct mounting on the insulation of the ceiling storage and as a suspended climate-controlled ceiling.

REFURBISHMENT

Retrofitted onto a concrete ceiling

Existing concrete ceilings can be enabled and easily retrofitted for use as energy storage. For this purpose, heat conducting profiles with pipe registers are mounted under the concrete ceiling. These regulate the temperature of the concrete and allow heat or cold to be stored and extracted.

Underneath this activation level, an insulation layer is installed, which is combined with support profiles. The heat-conducting profiles for the Raum-K Flex climate-controlled ceiling can be suspended in these support profiles. Afterwards, the heat-conducting profiles of the climate-controlled ceiling are panelled with standard drywall boards.

TRADEMARKMISSION FROM RAUM-K

For the health of people

Since Covid-19, the world and every single person has had to realise how precious health is. Breathing fresh air. Feeling good. Ensuring a good and healthy indoor climate in a private or professional environment - at home or in the office.
No more noisy air conditioners in summer or infections caused by cold draughts swirling around. Raum-K revolutionises the principle of solar radiation inside buildings - for surface air conditioning from top to bottom. For pleasant heating and cooling, to keep people and the environment healthy in a new climatic era.

For the heat revolution

The world is evolving. Both inside and out. Only if we succeed in heating and cooling without CO_2 emissions can climate change be positively influenced in the long term.
A crucial milestone in the energy transition is the efficient storage of regeneratively produced energy. Raum-K Buffer is the long-term solution for making a self-sufficient energy supply in existing buildings and even in new buildings a reality today.
People need heat and energy. Raum-K needs pioneers who understand, help shape and guarantee the long-term basic supply.

As pioneer

It has been known for fifty years that humanity has put itself and its own planet in serious trouble. Unfortunately, we are acting far too hesitantly and with too little commitment. Yet we all know that things can no longer go on as they are. With every day that passes, it becomes more difficult and more expensive to achieve one of the central milestones of our time, namely to reduce global warming to below 1.5 °C by 2035. This demands our joint action. Now!

For us at Raum-K, it is important to understand the use of energy from electricity and heat in a new way and to treat it in a way that creates value. After all, we humans need energy for everything we do. It is about cleverly storing energy that is already available, reorganising it, controlling it sensibly and making it usable where it is needed.

We are working on a future energy community where everyone - from homeowners to housing associations - becomes part of the sustainable energy and heat transition. Our drive for the large-scale building storage project is a people-powered, not-for-profit energy bonus system that has the potential to bring about much-needed social change.

Raum-K has the insight, the foresight and the foundation to walk the joint path, with module partners and energy providers into this new era and to actively shape it

CHECK LIST

Customer

Company: _____ Construction project: _____

Contact person: _____ Place: _____

Place: _____ Street: _____

Street: _____ Project Name: _____

Every indictaion creates clarity and planning certainty:

1 Surfaces
Total area of the BV: _____ m^2
Surfaces to be cooled: _____ m^2

2 Raum-K Grid
☐ Climate ceiling ☐ Climatic Sail (coming soon)
☐ Special design

3 Type of timber ceiling
☐ In-situ concrete ☐ Wood construction
☐ Reinforced concrete ribbed floor
☐ Filigree ceiling ☐ Prestressed concrete
☐ Ready-mixed concrete
☐ Roof construction (trapezoidal sandwich)
☐ Reinforced concrete slabs with intermediate components
☐ Other

4 Floor piping
☐ Plastic pipe ☐ Aluminium composite pipe
☐ Stainless steel

5 Pipeline system
☐ 2 Pipes ☐ 4 Pipes

6 Calculation parameters

COOLING:	RECOMMENDED	DESIRED
Room Temperature	26 °C	_____
Forerun	16 °C	_____
Recirculation	19 °C	_____

HEATING:	RECOMMENDED	DESIRED
Room Temperature	20 °C	_____
Forerun	35 °C	_____
Recirculation	28 °C	_____

7 Delivery point
☐ Distribution line
☐ Collector line

8 Combination with other systems
☐ Buffer storage tank ☐ Air conditioning systems
☐ Solar heating ☐ Geothermal energy
☐ Photovoltaics

9 Control distribution area
☐ According to cooling/heating load calculation
☐ According to the floor plan

10 Control units
☐ As part of the building services

11 Coordination with external trades
Are the housings for lighting, electrical outlets, sprinklers, etc. in the air-conditioning ceiling intended?
☐ No, not intended
☐ yes, specifically _____

12 Remarks

_____

_____

_____

_____

_____

_____

Questionnaire completed by

Name: Date: Signature: _____

Imprint

Publisher
Raum-K GmbH
Benninger Straße 70
87700 Memmingen

Modulpartner
Singular GmbH
Benninger Straße 70
87700 Memmingen

Brand Identity, Design, Bildsprache, Konzept und Text
Studio Iris, st-iris.com

Fotos p. 11, 15 © unsplash; p. 16 © Daniel J. Schwarz
Drawings © Florian Bühler

Status: 11/2021

RAUM K
New World of Energy

Comfort, ecology and economy combined in one ceiling

The ultimate goal of heating and cooling has always been a comfortable indoor climate. Nowadays, systems should also have an ecological energy balance and, of course, be as economical as possible in terms of investment and operation. The solution for all these requirements is the same:

An efficient climate ceiling that heats and cools comfortably.

This creates additional space for installation and allows the ceiling mass to be accessed. Raum-K with its module partner Singular is thinking in the future: with area-wide available throughout the building, which can heat and cool, and the engineering for the planning and design of the systems, together we are creating the energy turnaround.

Raum-K GmbH

Benninger Straße 70
87700 Memmingen

+ 49 8331 – 752 310
kontakt@raum-k.world
www.raum-k.world

Follow us and become par t of the Raum-K World:

@raumkworld
Raum-K
@raum_k.world

Design: st-iris.com / Status 11 / 2021