Lindab **Solus Theory system**

Simply the natural choice

Lindab®

Theory system Solus

Picture 1. Lindab Solus active chilled beam.

What is the Lindab Solus system?

Minimizing the energy cost for heating and cooling, by reclaiming the thermal energy from the exhaust air using a heat recovery unit is a natural part of any ventilation system today. It is a process that conserves the energy in the building, thereby saving huge amounts of energy on heating and cooling. Why not do the same on the water circuit?

System functionality
The main embodiment of the Lindab Solus system is to use High Temperature Cooling (HTC) and Low Temperature Heating (LTH) in one set of water pipes. Running HTC and LTH in the same system actually means having both heating and cooling at the same inlet water temperature.

By having the same inlet temperature on the entire system, no matter whether the individual zones needs heating, cooling or both, we can harvest the benefits by having a unified inlet temperature.

Depending on the season and the geographic location, there will be a need for cooling or heating in any building. In some cases, there will even be a simultaneous need for cooling and heating, due to different internal and external loads. In situations with simultaneous needs for cooling and heating, the return water, will as a result, be warmer or colder than the inlet water, depending on what part of the building the water is coming from. As the return water is mixed together, the temperature will stabilize at a near-inlet temperature once again, eliminating out the need for heating units and cooling units.

The main benefit of running heating and cooling at the same temperature, is that both heating and cooling will be handled by the same, two-pipe system. Besides providing huge savings on the building and commissioning costs, the two-pipe system will save on both running and maintenance costs as well, as only one set of pipes needs to be maintained.

To ensure that the system works properly, a constant flow is used throughout the entire system. This ensures that all the excess heat energy that may exist in some parts of the building, will in turn be carried to cooler areas, thereby creating an energy balance in the building. If the water flow is reduced the energy transfer between the rooms will also be reduced, resulting in a less efficient system.

This means that no valves, actuators or controllers are needed in the individual rooms, offering a huge saving on the building costs.

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Why Lindab Solus?

High capacity
The main parameter with a direct impact on the heating and cooling capacity of a system is the effectiveness of the cooling/heating coil in the active chilled beams. One way of sizing a cooling or heating system has been to seek high temperature differences between the water circuit and the air in the room. The efficiency of the coil has not always played the most important part, as it has been widely accepted that a low quality coil is used to save money in the construction phase. As the Solus coil offers a very high level of efficiency, it is possible to gain the same output effect with a lower Δ_t than with less efficient coils. The high temperatures used for cooling, also offers a higher COP than normally gained by using conventional cooling.

Higher water temperatures for cooling
Normally, a cooling system will run at quite low water temperatures, whereas a heating system will run quite high water temperatures to get as high a difference in the temperature between the water and the air in the room as possible. The higher the difference in temperature, the higher the capacity.

With HTC and LTH, the temperature difference will be extremely low, this is why the effectiveness of the coil needs to be extremely high.

The coil fitted in the Lindab Solus beam delivers a previously unseen capacity per watt input, and thereby ensures a high capacity despite the low temperature differences in the Lindab Solus system.

Optimal air distribution at low air velocities
To ensure a great distribution, and a draft free environment, the Lindab Solus beams are supplied with a special angled nozzle, ensuring optimal comfort a result.

The nozzles spread out the inlet air in a 30° pattern, thereby lowering the air velocities and thus reducing the risk of drafts.

Efficient product
By shifting focus from the temperature differences, to the coil efficiency, it is possible to get effective capacities, while running a lower Δ_t on the water circuit than normal. By moving away from the low cooling temperatures and the high heating temperatures, you end up having a convergent inlet temperature for both.

Effectively, this means that it is possible to run an inlet temperature of between 20-23 degrees Celsius on both heating and cooling and thereby satisfy both cooling and heating, in the same two-pipe system, at the same time!

COP

Heat pumps
As the difference between the inlet water temperature in the Solus system and the temperature of the heat pump media will be much lower than on a conventional chilled beam system, heat pumps can be utilized much more efficiently on the Solus system. For cooling cases, the Δ_t between the inlet water and the heat pump media will normally be 6°K lower on the Solus system than compared to conventional systems. The heat pump COP value can therefore be expected to be 20-30% higher when using a specific heat pump on the Solus system, as the lower Δ_t offers a higher yield.

The exact same principle will apply for heating cases as well, making heat pumps a perfect companion for the Solus system.

Picture 2. Open faceplate.

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HTC and LTH in active chilled beams – new application area

The new Lindab Solus system is the first active chilled beam system on the market featuring High Temperature Cooling and Low Temperature Heating. HTC and LTH are two, new ways of handling the cooling and heating needs in buildings. As the names indicate, HTC utilizes relatively high temperatures in the cooling circuit and LTH uses relatively low temperatures for heating resulting in potentially large savings on the energy normally needed to heat and cool the building.

Due to the relatively low inlet temperature of 23°C maximum, stratification problems will be a thing of the past. Normally a high inlet temperature (often up to 80°C) will cause a very high temperature difference between the induced air and the room air, thereby creating stratification. But as the inlet temperatures for the Solus system are quite close to the desired room air temperature, stratification is no longer a problem.

Expected room temperatures

As the water flow in the Solus beam is constant and the temperature of the inlet water only changes according to the outdoor temperature, small fluctuations in the room temperature may be expected. As the temperature drops or rises in a room, the heating/cooling capacity of the beam coil will raise respectively. The capacity will continue to rise, as the temperature continues to drop, until the maximum capacity is reached and vice versa for summer

In most cases, the indoor temperature will vary from 20 °C to 25°C, from the coldest to the hottest day of the year, depending on the internal and external loads in the room.

Why High Temperature Cooling compared to normal Chilled Beam systems?

With the new Lindab Solus system, it is possible to achieve much higher savings, as the Solus system allows you to run the same temperature setting for both heating and cooling. This means that you can reuse the thermal energy in the return water circuit, much as you would regain the thermal energy on ventilation.

In a conventional chilled beam system, the cooling circuit consists of colder inlet water and warmer outlet water, than in the Solus system. The warmer outlet water will need to be cooled in a cooling unit or free cooling unit before returning to the beam as inlet water. The heating circuit is vice versa of the cooling circuit, so why not make this into an advantage?

By running an inlet temperature of 20-23°C in the water circuit for areas in need of heating and cooling, the outlet hot and cold water is mixed together. As a result, it will only be necessary to either cool or heat the output water to reach the inlet temperature once again. By only having to cool or heat the water, no energy is wasted by doing both at the same time.

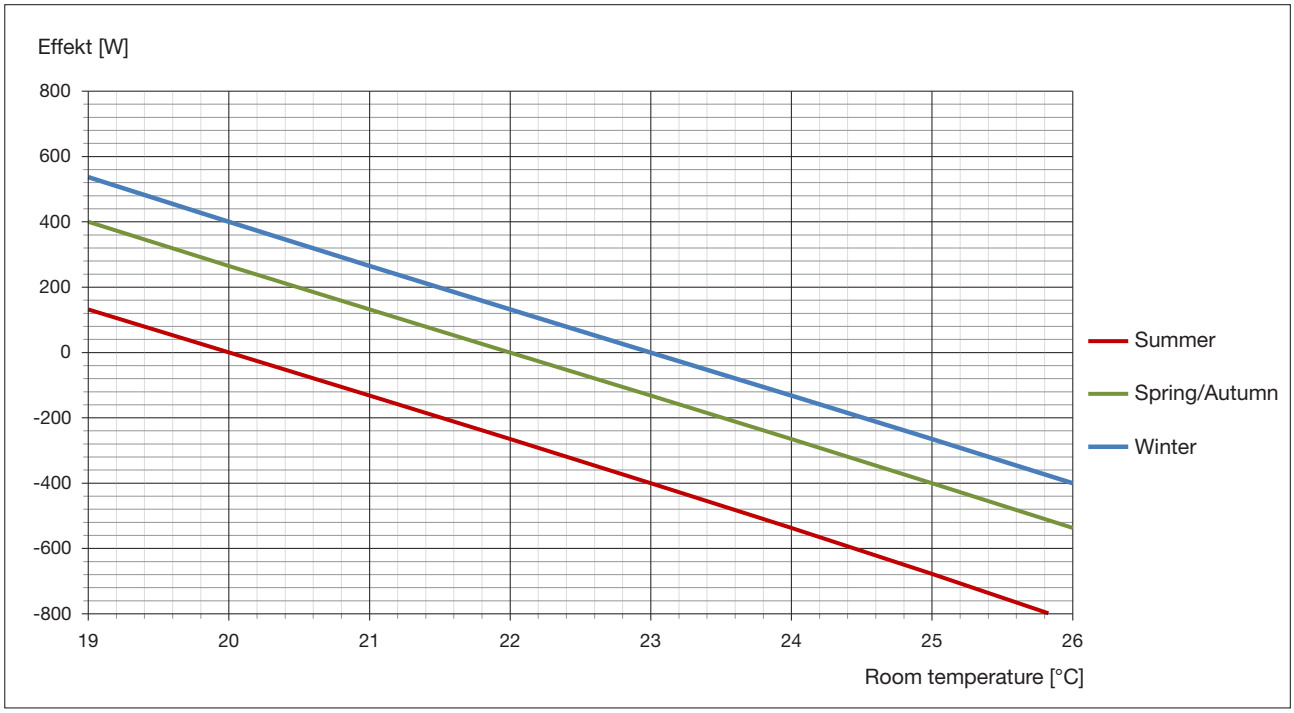

Diagram 1. Expected room temperature, at different loads. Thermal load per 3.0 m beam.

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Seasons

Spring and Autumn

In spring and autumn the usual scenario will present the perfect opportunity for redistributing the buildings thermal energy, as the external thermal loads can vary a great deal. This will result in a need for cooling in one part of the building and a heating need in another part. To handle both the need for cooling and heating, the inlet temperature should be set to 22°C. Should the need for cooling be larger than the need for heating, free cooling should be available most of the time, depending on location and weather.

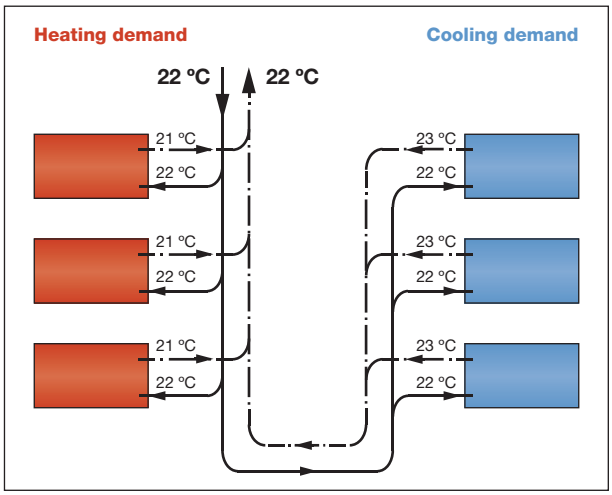

Figure 1. Water temperature set, Spring/Autumn. 50% cooling, 50% heating need.

Summer

During summer, a general need for cooling could be expected in most of the building throughout the day. To gain the best cooling advantage, a running inlet temperature of 20°C should be used in the water circuit. As the expected thermal scenario during summer will not give much opportunity for recycling the thermal energy, a cooling unit will be necessary most days during summer. Depending on geographical location and weather, savings may still be obtainable as a high level of free cooling may be available. Due to the high inlet temperatures in the water circuit, free cooling can be gained at a relatively high outdoor temperature.

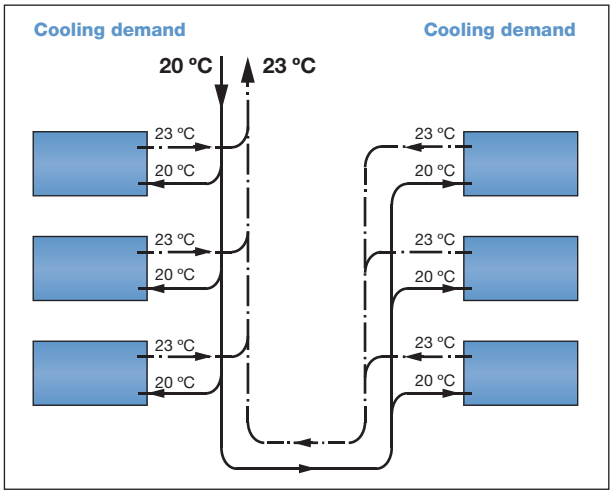

Figure 2. Water temperature set, Summer. 100% cooling need.

Winter

In the coldest months of the year, external loads will often be so small, that a general need for heating is dominant in the building. Therefore it can be necessary to utilise a heating unit to reach the needed inlet temperature of 23 °C in the water circuit. Never the less, internal loads may still create local hot spots, where cooling is still needed, despite the low outdoor temperatures. As a result, energy savings may still apply during winter.

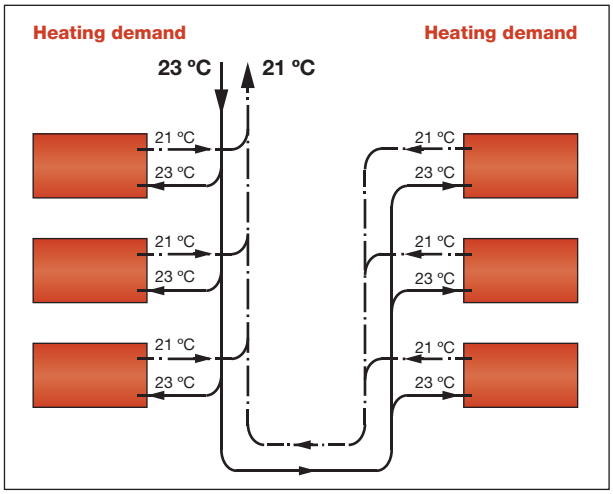

Figure 3. Water temperature set, Winter. 100% heating need.

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Energy transfer in buildings

South and north facades means different demands
In most buildings, the need for cooling and the need for heating are two independent factors that do not have a direct relation to each other. There may be a need for cooling on the south facade and a need for heating on the north facade at the same time.

Normally this scenario will be handled by running a cooling unit and a heating unit at the same time, to cool the rooms facing south and heat the rooms facing north. But why not use the in-house energy, by distributing the excess heat energy from the south facade to the north facade?

Previously no system has been able to deliver this functionality, but this is now possible with Lindab Solus.

Energy savings with the Solus system
The fact that the water temperature for both inlet and outlet will be very close to the room temperature, means that only a small amount of energy needs to be added to keep a steady temperature in the system (for heating & cooling demand scenarios). This has a direct impact on the expense of running the building's cooling unit and heating units and will result in cost savings.

Finding the most energy efficient solution is a must in most building projects. When talking cooling, heating and ventilation, the most energy efficient solution has for many years been gained by using chilled beams. By weight, water carries approximately 3400 times as much heat energy as air, this is why the energy transport for heating and cooling is much more efficient when using water as media, as opposed to air.

Using the different demands in the building
By running an inlet temperature of 20-23°C, the energy needed to sustain the operating temperature will be provided by the building itself. Water coming back from the warm southern facade, will be mixed with the colder water from the north facade, thereby minimizing the energy used by the cooling and heating units.

In normal cases it is necessary to run either a cooling unit or a heating unit to achieve an optimal output temperature, but it will never be necessary to run both at the same time with the Lindab Solus system.

The result: Gain a great indoor climate, while saving both money and the environment.

Lindab Solus can be combined with any conventional heating or cooling source, including air-to-water and water-to-water heat pumps.

Including free cooling
Due to the high temperature cooling in the Solus system, free cooling can be achieved at higher outdoor temperatures. This means that the number of days where free cooling can be utilized is greatly expanded using the Solus system when compared to a regular cooling system. As the normal Summer temperature set for cooling in the Solus system would be 20-23°C, partial free cooling can be achieved at an outdoor temperature of 22°C, whereas 100% free cooling will be reached at an outdoor temperature below 16°C. This factor alone shows huge savings on running the cooling unit, when comparing the Solus system to a regular cooling system.

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No regulation valves

A Lindab Solus system is basically built as a regular chilled beam system, with a few, energy and cost saving differences.

Components of a Lindab Solus system

- Cooling unit
- Heating unit
- Free cooling unit (optional)
- Solus beams
- A system of water pipes

The running temperature will be kept at the desired level thanks to a temperature control in the plant room. As the same temperature is needed for both cooling and heating, no temperature sensors are needed in the building. On the air side, a constant flow is nothing new, but a constant flow through the water coil in all the chilled beams during working hours is a large change. The constant water flow eliminates the need for valves and actuators, providing a further saving on building costs. The absence of valves will also present a lower pressure loss, providing the opportunity for using smaller pumps.

To ensure a perfect thermal balance throughout the building, all beams in the system need to be running at the same time. This means that all regulation equipment normally used in the individual rooms are made redundant. Not having to buy and adjust valves, actuators, room regulators, temperature sensors, CO_2 sensors and presence sensors not only provides huge savings but also shortens the installation time considerably.

Constant and optimized low water flow
To ensure the optimal results when running HTC and LTH, a constant air and water flow is needed during the operational period. For an office building this would mean during normal working hours. The constant airflow is needed to ensure induction of room air into the chilled beam, and the constant water flow is needed to ensure an optimal capacity from the high efficiency coil. The water flow should be calculated based on a temperature of 20-23°C, in the summer case with 100% cooling need.

No need for simultaneous heating and cooling ever again!
When running the Lindab Solus system, there will still be a need to install cooling and heating units in the building don't need full stop, but as the thermal energy in the building is balanced by the Lindab Solus system, there will never be a need to run both units at the same time.

During days where the need for heating and cooling balance each other out, both the heating and cooling units can be switched off completely.

Achieving the right air flow
In addition to not having a need for regulators and sensors on the individual beams, the damper normally used to regulate the air flow on the VAV system can likewise be cut from the system.

As the relation between the air pressure and air volume is quadratic, air volume will only differ minimally from the desired air volume.

This means that it will often take out be possible to leave out individual branch dampers, as the dampers on the main duct runs will be sufficient.

This will result in a direct saving on the construction cost, but will also culminate in a saving on the running costs, as the pressure loss across the individual dampers no longer needs to be overcome by the AHU.

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Savings due to energy transfer between zones

When choosing the Lindab Solus system, there will always be a large saving on the installation costs and a saving of the energy required to cool and heat the building. The latter will depend on the configuration of the system and internal/external loads. To illustrate the expected saving on the running cost in different situations, we refere to the Master work: Innovative Active Chilled Beam Application, Application of two-pipe system for heating and cooling (Rouzbeh Gordnorouzi, 2013).

This study was conducted by focusing on 6 different, plausible scenarios, showing an annual saving on the total energy needed in the building for cooling and heating of 3 – 15% when comparing the Lindab Solus system with a conventional chilled beam system. When only considering the energy savings for annual total cooling, the savings will be between 5 – 57%. The 5 different scenarios considered here will be applicable to different buildings depending on several factors, but as scenario 2 will fit most projects, an annual saving on the energy needed for cooling may be expected to reach 45%.

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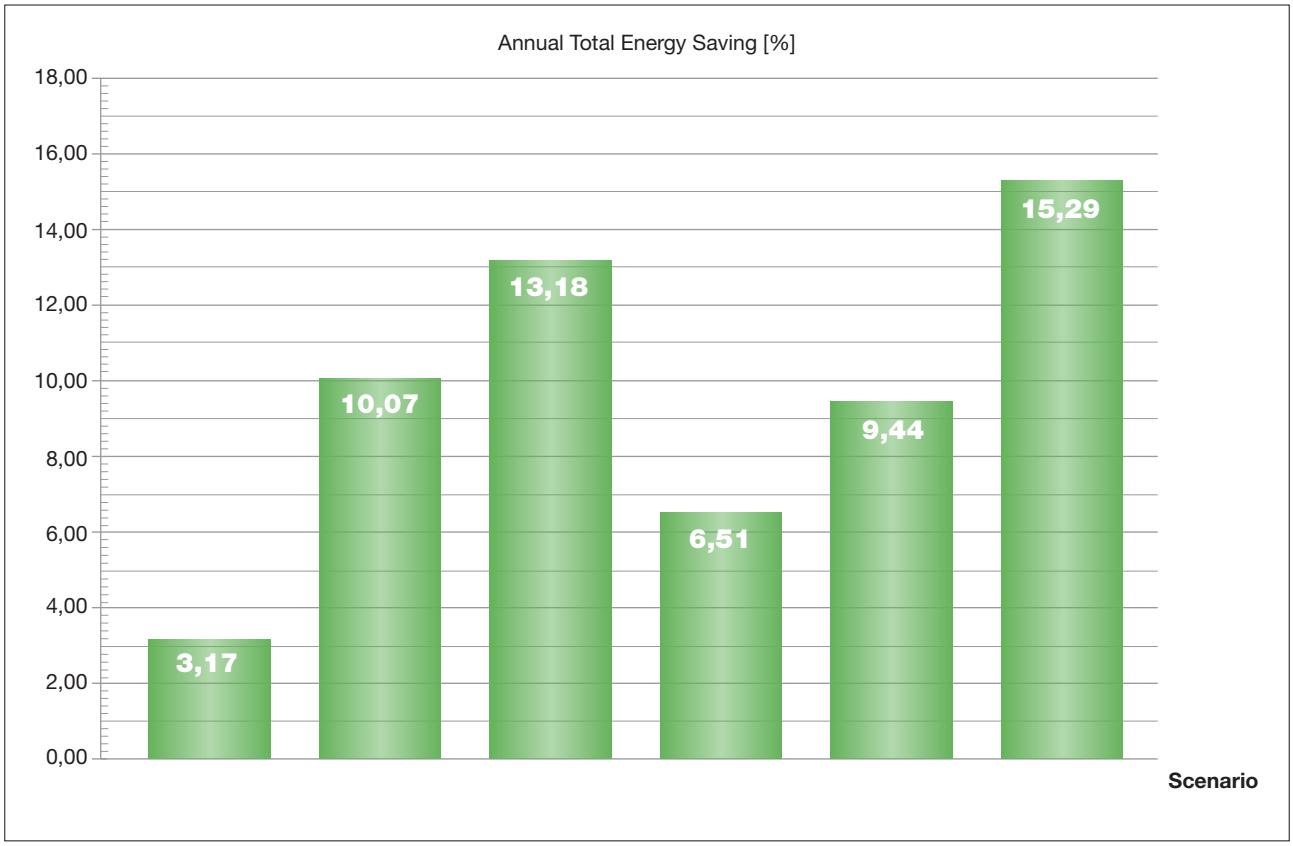

Diagram 2. Energy saving percentage for the total energy demand, heating and cooling, when comparing Solus and a conventional chilled beam system.

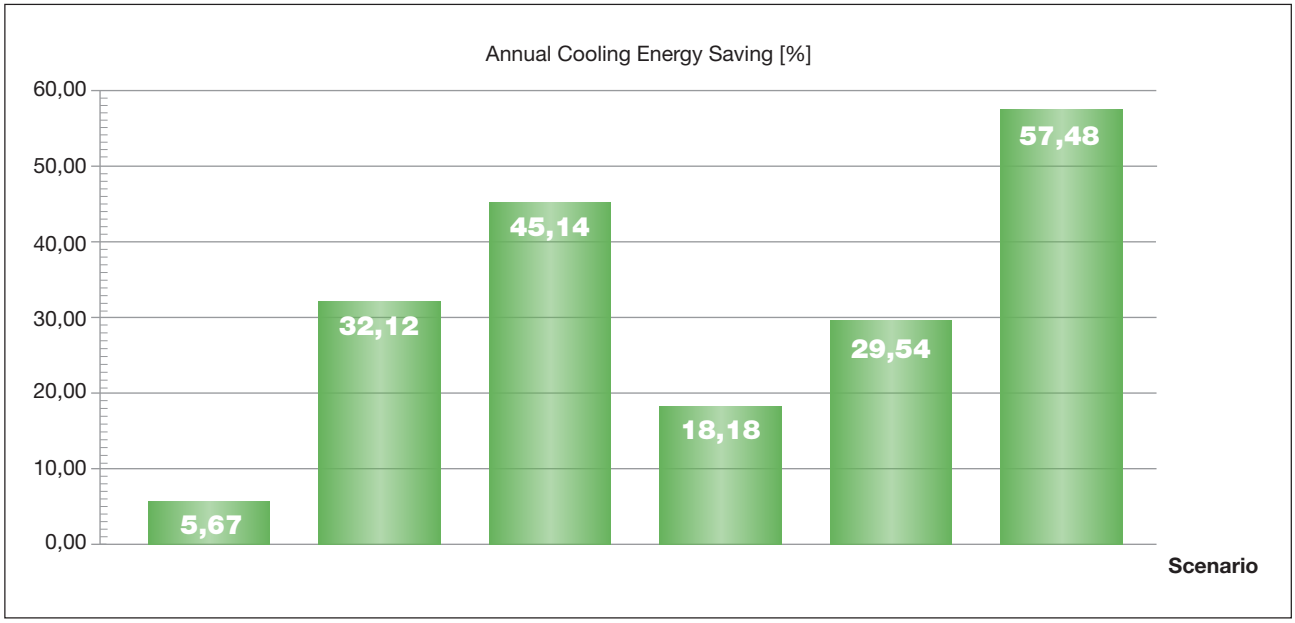

Diagram 3. Energy saving percentage for the energy demand, cooling only, when comparing Solus and a conventional chilled beam system.

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Saving on system → cheaper total system

Recycling energy
As with the common AHU air heat exchanger, the Solus system employs a similar function for the water circuit. This means that the energy amounts normally wasted on running heating and cooling at the same time is levelled out, by mixing the water flow.

No valves, actuator or other kind of room regulation
The Lindab Solus system is an effective, yet simple system. Amongst the unique savings you gain with the Lindab Solus system is the fact that no valves and actuators are needed for the Solus system. To ensure an optimal thermal balance, a steady flow on all beams is essential. This means that all individual valves and valve control equipment are made redundant.

No room sensors
As the system needs to be running at all times, no occupancy sensors are needed. Outdoor temperature sensors and other general control sensors will be needed as normal.

Only one set of pipes
As all zones in the building will receive both heating and cooling through the same set of pipes, huge saving on piping can be achieved. No radiators. The Lindab Solus beams can cover most buildings heat requirements, even in northern countries. Therefore in most cases it will not be necessary to install radiators, floor heating, heat panels or any other kind of heat source when applying the Lindab Solus system.

Smaller pumps
Due to the greatly reduced water pipe pressure, the size of the pumps can be reduced. This will save both on construction and running costs.

Green product

Simple product
Many of the components that normally form part of a chilled beam system are made redundant in the Lindab Solus system. Due to this lesser number of components needed and the chilled beam itself, the Solus system results in cheaper installation and maintenance costs than those of a regular chilled beam system.

Energy saving
One of the main aspects of choosing the Lindab Solus system is to achieve energy savings by simply balancing out the temperature in the building. On days where both cooling and heating needs are present in the building, the Solus system automatically reuses the energy already present in the building, before calling on the cooling unit or heating unit.

Sustainable energy sources
As the inlet temperature on the water circuit is much higher than would be considered normal for cooling, free cooling can be applied much more often than on a regular chilled beam system. This makes the Lindab Solus the perfect choice in projects featuring free cooling units.

Cooling towers
Cooling towers enable 100% free cooling, as long as the outdoor temperature is low enough. In a normal chilled beam system, a temperature set of 14-17°C is very common. This means that free cooling can only be achieved when the outside wet temperature drops below 17 °C. To achieve 100% free cooling the wet temperature has to drop below 14°C. Not so with the Lindab Solus System.

Recyclable product

The Lindab Solus beams are made primarily of aluminium plates, copper pipes and steel details, and are therefore 100% recyclable.

Short payback time

Eliminating valves, actuators, condensation protection, regulation units and other equipment from the chilled beam system presents a huge saving by itself. Adding the savings from only having to install a single set of pipes for heating and cooling, together with the possibility for optimal free cooling, the Lindab Solus system will not only present a low installation cost, but will also prove to be a cost saving over time.

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FAQ

Is the Solus system more expensive to install?

- No, quite the contrary. Due to the simple no regulation component build-up, the system is both faster and cheaper to install, compared to a normal chilled beam system.

Are there any changes in the maintenance costs when comparing Solus to a regular chilled beam system?

- Yes. As the Solus system does not contain any moving parts, breakdown due to wear is not an issue. There are no valves that need to be cleaned, no regulation equipment that needs to be adjusted or reset and no electrical parts needing updates. Therefore the Solus system will only require an absolute minimum of maintenance, thereby greatly reducing the maintenance cost.

Will the Solus system be sufficient to meet my cooling and heating demands?

- When comparing efficiency as watt per degree Δ_t between the mean water temperature in the coil and the room temperature, the Lindab Solus beam is market leading. Though, as the mean water temperature will be very close to the room air temperature, the maximum cooling and heating output will not be as high as on a regular chilled beam, when seen as a total. Therefore the Solus system should be seen as the perfect solution in projects where the cooling and heating needs are medium.

Is free cooling a requirement?

- The use of free cooling is not a requirement for the Lindab Solus system. Even without the use of free cooling, the Lindab Solus system will present savings on the running costs, due to a high COP on the cooling unit, alongside large reductions on the installation costs when compared to a conventional chilled beam system. Nevertheless, applying a free cooling unit to the system will enable much larger savings on running costs when compared to not having any free cooling. As the water inlet temperature for the summer scenario (cooling need dominant) is 20°C, free cooling can be obtained at an outdoor temperature of as high as 19°C (100% free cooling at 16°C), versus the normal case of 13°C (100% free cooling at 9°C). This means that free cooling will be available more frequently when using the Lindab Solus system, thereby larger savings can be gained with a Lindab Solus system with free cooling versus a conventional chilled beam system with free cooling.

Why should the water flow be kept constant?

- Without a constant flow throughout the building, the energy transfer may be interrupted or even nullified. Some rooms will be warm, and heat the water in the circuit, other rooms will be cold, and will cool the water. If some or all the cold rooms were excluded from the water circuit, the water would remain warm, and a cooling unit would be required or vice versa a heating unit.

Will the water flow rate need to be regulated?

- No. The flow in the Solus water circuit should be maintained at the highest of the two values
- Needed water flow with 100% heating need
- Needed water flow with 100% cooling need

What should the primary inlet air temperature be?

- The primary inlet temperature should be equal to the water inlet temperature.

Is the Solus solution suitable for both old and new buildings?

- The Solus beam is suitable for ventilation, cooling and heating in any kind of building, as long as the cooling and heating need does not exceed the capacity of the Solus beam. In most cases, the Solus beams capacity will be too low for older buildings with a poor level of insulation, this is why the Solus solutions should be considered mainly for new projects.

Will protection against condensation be necessary?

- The dew point will vary from building to building and from country to country due to the climate. A dew point of 20°C or higher will be extremely seldom, and condensation protection will therefore not be necessary when using the Solus solution. However the climate varies a lot, this is why the dew point needs to be calculated locally.

How much insulation should be applied to the water pipes?

- None. As the water temperature is very close to the room temperature, and the main idea within the Solus solution is to balance the thermal energy in the building, heat loss from the pipes will only have a positive effect on the heat balance of the building.

How many zones should the building be divided into?

- One. As a large zone with many rooms will offer a better opportunity for heat balancing, the entire building should consist of one single zone.

How will the water temperature and flow be controlled?

- The water temperature[1] will be controlled by an outdoor thermometer and a central regulation unit (not supplied by Lindab). The flow will not be altered, as a constant flow is needed.

[1] *summer = 20°C , winter = 23°C*

Most of us spend the majority of our time indoors. Indoor climate is crucial to how we feel, how productive we are and if we stay healthy.

We at Lindab have therefore made it our most important objective to contribute to an indoor climate that improves people's lives. We do this by developing energy-efficient ventilation solutions and durable building products. We also aim to contribute to a better climate for our planet by working in a way that is sustainable for both people and the environment.

Lindab | For a better climate