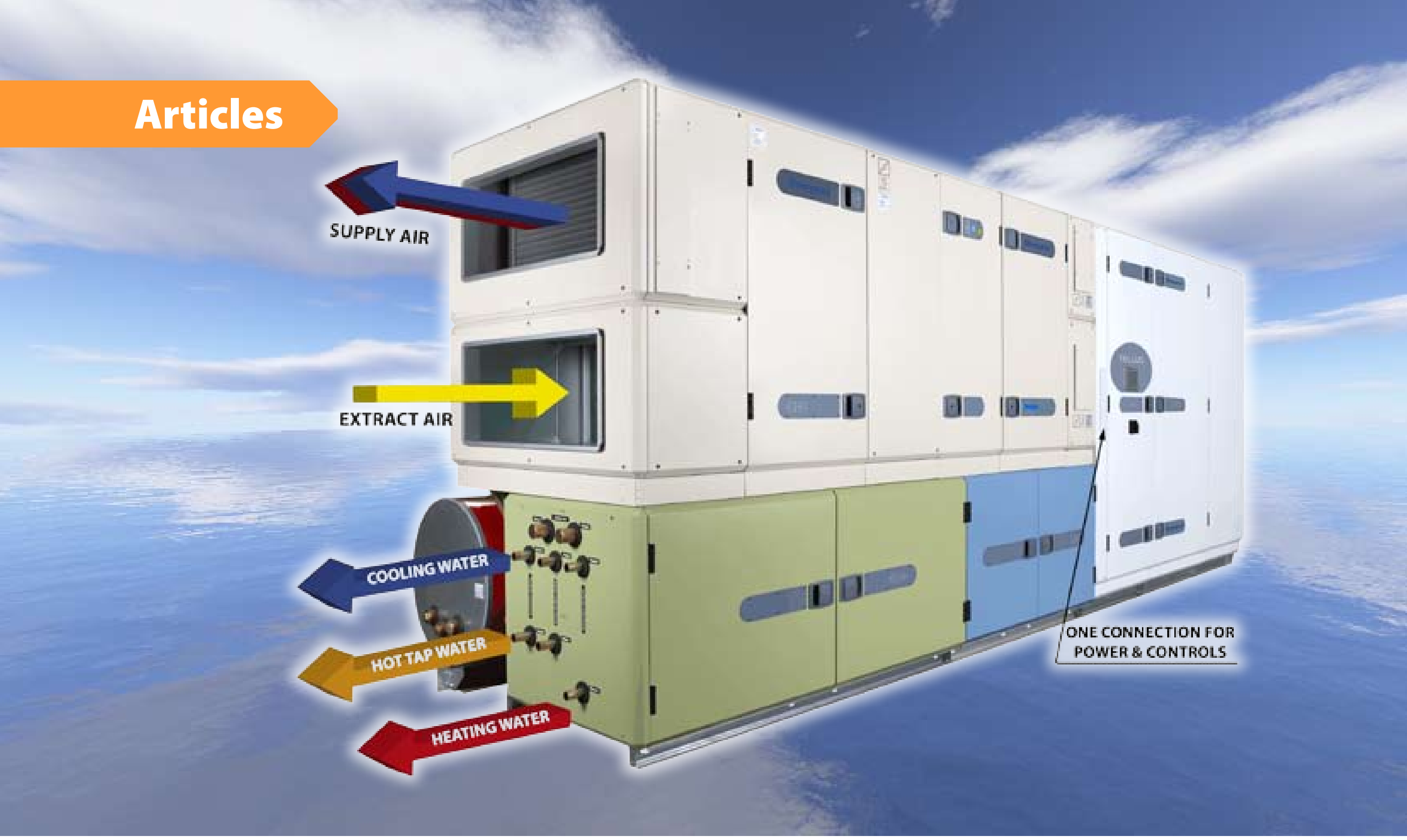
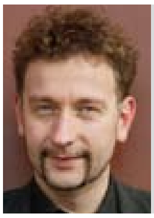


Figure 1. TELLUS Climate system from Swegon is a complete, modular system product for the production of ventilation, heating, cooling and hot tap water. Its four modular blocks are: Air Handling Module (light brown), Hydronic module (greenish), Chiller&Heat Pump Module (blue) and Energy Exchange Module (white).

Holistic approach creating the best comfort using the least energy



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Swegon TELLUS – The next step for multifunctional HVAC units

For the past seven years Swegon has focused on system development and system products, realising that many improvements in comfort and energy saving can only be achieved by a holistic approach.

TELLUS is a complete HVAC and energy plant producing acclimatized air, waterborne cooling, heating and hot tap water all at the same time or independently of each other. Due to the integrated, modular design energy efficiency is increased and acclimatisation costs are dramatically reduced.

The production sites, R&D centres and laboratories of Swegon comprise production of heating, cooling and ventilation, flow control and indoor climate products. Four of these sites where actively involved in the design of TELLUS.

The first units were displayed in the spring of 2012, at the international HVAC fairs Nordbygg in Stockholm and Mostra Convegno in Milano.

The target for the development was to make a boxed product with a minimum of external interfaces that could satisfy the total indoor climate needs of commercial

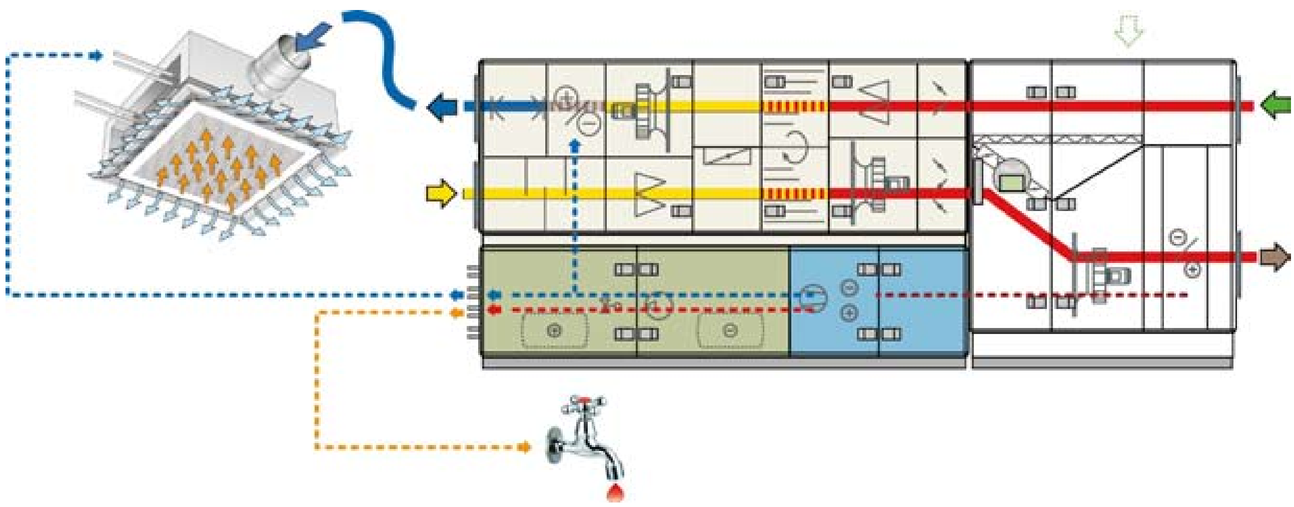

Figure 2. Example for cooling and hot tap water need, daytime. Air Handling Module (light brown), Hydronic module (greenish), Chiller&Heat Pump Module (blue) and Energy Exchange Module (white).

buildings between 600 m² and 4 000 m², in European climate conditions.

Highest priority is always to obtain the desired comfort with the least amount of purchased energy. An integrated system enables demand control of temperatures and flows for all energy transfer in the building.

- **Firstly**, running conditions for compressors and fans are improved when over-/under temperatures and high airflows are avoided.
- **Secondly**, energy losses resulting from high pressures across regulating devices such as dampers and valves are minimised when production matches demands.
- **Thirdly**, it is possible to provide efficient energy recovery and redistribution of the energies supplied and retrieved from the building. Thermal energy of extracted air is fully recovered and utilised to meet simultaneous heating and cooling demands.

Operation Swegon TELLUS

TELLUS is a complete, modular system product for the supply of ventilation, heating, cooling and hot tap water. All these energies can be produced simultaneously or independently from each other, according to the actual demand.

TELLUS suits buildings between 600–4 000 m² due to its cooling capacity between 25–82 kW, heating capacity between 12–60 kW and air volumes between 1 000–16 000 m³/h. TELLUS can be used in regions with outdoor temperatures between +45°C and –20°C and can be placed indoors or outdoors.

Besides conditioned supply air, TELLUS provides cooling water for comfort modules, chilled beams or fan coils and heating water for comfort modules, radiators or under-floor heating.

Swegon TELLUS consists of 4 modules that can be combined in different sizes to suit the energy need of different projects (see **Figure 1**).

General principle

The outdoor air passes through ducts, or in outdoor version, directly through the Energy Exchange Module (green arrow and read line in **Figure 2**). Subsequently, the air passes through the Air Handling Module where it is filtered, preheated or cooled by the hygroscopic rotor. It then passes through a change-over coil for desired supply air temperature.

The Hydronic Module distributes warm and cold brine from the Chiller & Heat pump Module to the warm and cold internal 500 litre tanks, to the change-over coil and the heat exchangers between TELLUS and the secondary circuit for the building (waterborne cooling, heating and hot tap water). Hot tap water is optional and one or multiple hot tap water tanks can be installed in cascade. The brine flows through the coil in the Energy Exchange Module, where it absorbs or emits heat. Warm and cold brine are produced by the Chiller

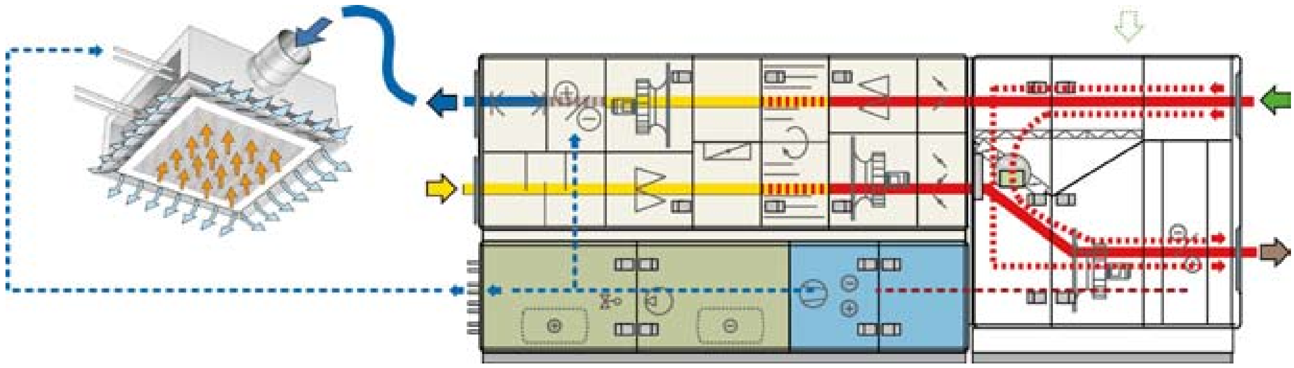

Figure 3. Example for boosted cooling need in summer, daytime. Air Handling Module (light brown), Hydronic module (greenish), Chiller&Heat Pump Module (blue) and Energy Exchange Module (white).

& Heat Pump Module with two tandem vapor injection Copeland compressors.

The Chiller & Heat Pump Module, that uses R410 as a refrigerant, can be considered as a "water-water unit" when stand-alone, together with the Energy Exchange Module as an "air-water unit" and together with the Hydronic Module as a multifunctional unit.

Operation mode for peak cooling periods

The coil in the Energy Exchange Module receives the extract air passing through the Air Handling Module; but due to the fact that air volumes normally are demand controlled and limited to the actual need of air changes in the building, the amount of air passing over the coil is not sufficient to heat and cool the entire building. For this reason the Energy Exchange Module is fitted with a circulation damper that allows up to three times as much air volume over the coil than the maximum extract air from the building (**Figure 3**).This function is patent pending and allows to get rid of the excess heat in summer and sufficiently retrieve energy from the air at winter time.

Operation for simultaneous cooling and heating

Swegon TELLUS can supply heating and cooling independently or, like in the example in **Figure 4**, both at the same time. During spring and autumn there are periods when many buildings have a simultaneous heating and cooling need. In this case the cold water for climate beams is available at the same time as the heating for e.g. radiators and hot tap water. The pri-

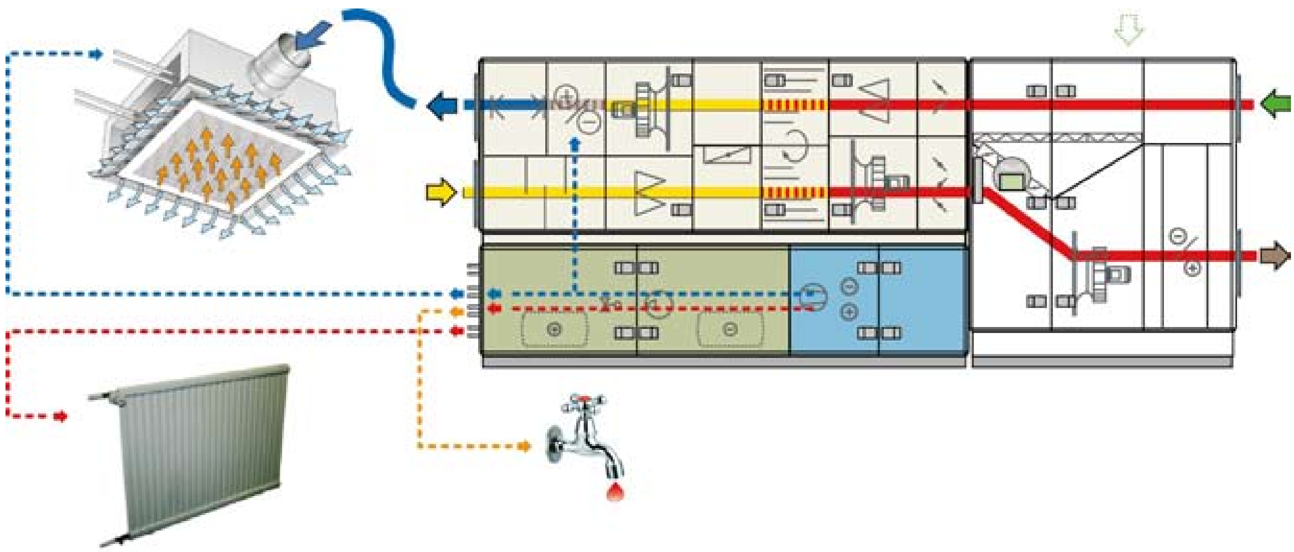

Figure 4. Example for cooling, heating and hot tap water at the same time, daytime. Air Handling Module (light brown), Hydronic module (greenish), Chiller&Heat Pump Module (blue) and Energy Exchange Module (white).

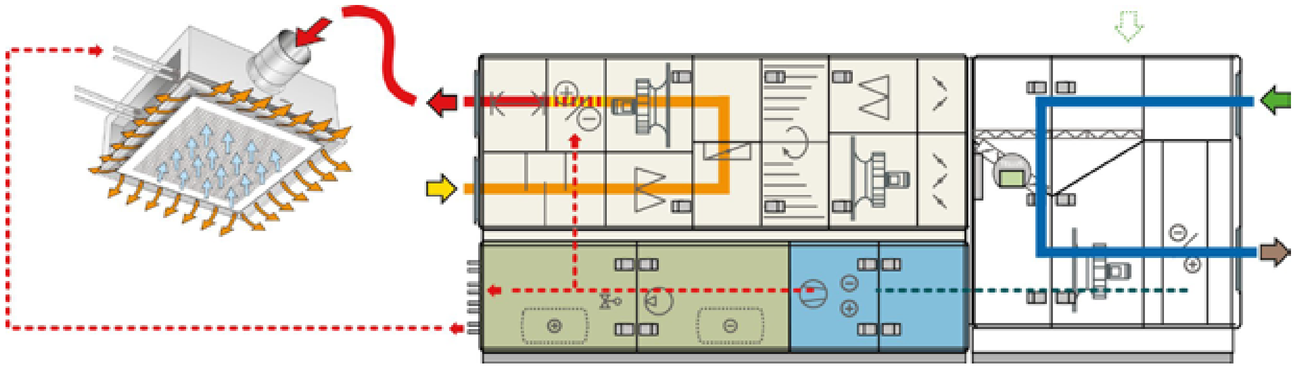

Figure 5. Example for heating with climate beams, night time. Air Handling Module (light brown), Hydronic module (greenish), Chiller&Heat Pump Module (blue) and Energy Exchange Module (white).

mary energy need is produced as efficiently as possible and the secondary is facilitated by the emerging excess energy.

Night time operation

Fresh air is not required to keep unoccupied buildings warm, e. g. during weekends and nights. The heating needed will be facilitated by circulating a sufficient amount of outdoor air over the coil in the Energy Exchange module. If radiators or under-floor heating are used, warm water will be supplied by the exchanger in the Hydronic module. However, if climate beams are used, an accessory internal circulation damper can be included (see **Figure 5**). This allows heating at night without pressure loss of the rotor or the supply filter. Even if the supply fan will need some electric energy, this is a fraction of the energy saved by the increased COP of the compressor. Heating with climate beams will normally allow an up to 10K lower water temperature than with radiators, which increases the COP by up to 30%.

Energy saving with Swegon TELLUS

There are many ways Swegon TELLUS saves energy. Some methods are traditional and some are innovative. All have in common that they strive for minimising the purchased external energy as much as possible without neglecting the comfort of the indoor climate.

The traditional methods, which are used by the high quality HVAC products from Swegon that are parts of TELLUS, includes the **Hygroscopic rotary heat exchanger** that provides 80–85% heating and cooling energy recovery and dehumidifies the supply air. This saves an additional 6–24% cooling energy, depending on the outdoor climate. Furthermore, **Speed controlled fans and pumps** allowing demand controlled ventilation, will save between 25–40% of annual fan energy. Finally, **A-class chiller** components with large operating range, due to vapour injection technology allow outdoor temperatures between –20°C and +45°C.

An intelligent control system can reduce energy consumption using traditional methods such as **summer night cooling, night set-back or scheduled running times**. However, a system approach can provide additional energy saving features.

SMART Link valve optimisation ensures that the chiller/heat pump module delivers **brine temperatures** that match the real needs of the building. The cooling production will now always be as warm as possible and the heating production as cold as possible. This increases COP and EER and lowers pressure drops across valves in the brine circuit.

Also the distributed cooling and heating water to e.g. beams or comfort modules can be demand controlled (*All Year Comfort- functionality*) which saves up to 10% of energy annually by **optimised temperatures** and more open valves. This function also ensures supply water temperature to chilled beams above condensation point by a humidity sensor in the extract air.

The available cooling energy of the outdoor air can be used directly through the supply air and indirectly by cooling brine in the integrated 500 litre cooling tank (**free cooling**). Cold water can be transferred to different parts of the building efficiently. This limits the running time of the compressors and reduces fan power.

Due to the circulation possibilities between extract and supply air and outdoor and exhaust air, the amount of **fresh air supplied to the building** is independent of the total amount of air used for heating and cooling production. This will save both fan power due to lower pressure drops and heating and cooling energy due to smaller ventilation losses.

Innovative ways to improve energy efficiency with Swegon TELLUS

Free heating during cooling season and free cooling during heating season

Heat pump technology always results in that both heating and cooling is available simultaneously. The excess heating energy that is released while cooling, either to be removed from the system or can be used to heat special parts of the building or the hot tap water tank, without additional costs. The integrated heat and cold tanks can be pre-loaded with the free available energy in order to create a better starting point. Thus, the primary need of either heating or cooling must to be purchased while the secondary is free. This increases the total efficiency of the unit immensely, especially since 30% to 40% of all the annual hours in Europe have outdoor temperatures between +5°C and +15°C which approximately is the temperature range where a building has a simultaneous heating and cooling needs. Hot tap water is needed throughout the year and there might be areas, such as server rooms, that require constant cooling. These factors improve the energy saving calculation.

Extract air and temperature recovery

In TELLUS the extract air, if available, is used in the heating and cooling production. Only if that air volume is insufficient the extra fan in the Energy Exchange Module has to be used, feeding more air through the outdoor air bypass damper. This fan will run significantly less than that of a free-standing heat pump, increasing the EER and COP of the unit. This combination of a small and a big fan in series is patent pending. On top of that, the extract air often has a more feasible temperature than the outdoor air for heating and cooling production. So even remaining extract air energy, after the hygroscopic rotor, will be recovered here (the last 15–20%), making TELLUS more efficient.

Intelligent defrost system

When defrosting is needed the unit continues to deliver heat. This is made possible with another patent pending functionality that allows the rotor to temporarily lower its efficiency so that warmer extract air can be used to defrost the coil in the Energy Exchange Module. In the meanwhile the extra energy to the supply air heating coil will be supplied by the internal warm tank that has been pre-charged. This means that defrosting can be realised swiftly and without affecting the produced comfort.

Central Controls for optimisation

Central controls can be reached locally or through Internet, by a bus cable from the BMS-System or by the integrated touch screen and create the optimum interactivity between all TELLUS modules, always supplying the needed energies as efficiently as possible to the building. Self-supervision, energy monitoring, set-point adjustments and full overview are possible e.g. by the integrated web-server.

Figure 6. Internal controls can be used by build-in touch screen or remotely.

Over all energy efficiency of TELLUS on annual basis is high. Annual system level efficiency of TELLUS is >4.5 when calculated as ratio of all energy needs of building supplied by TELLUS system and the amount of purchased energy used by TELLUS. These data are also verified by the laboratory readings and test installations in a Swedish office building during year 2012.

Conclusion

In conclusion, TELLUS supplies the total heating and cooling energy of a mid-size commercial building as efficiently as possible. The excess energy that the main process releases covers secondary energy needs of the building. The presented integrated, border crossing technologies save energy, space and installation time; removing demarcation lines typical for installations with many suppliers involved. This creates security and avoids system losses. Swegon TELLUS simplifies the design process, the installation and the maintenance of a HVAC system by reducing it to one integrated energy distribution unit.

The general approach of using known technology and combining it in an innovative way also triggered the work on the M-value, together with CIT Management (Chalmers University, Gothenburg) that attempts to create a common denominator in the evaluation of different HVAC systems available on the market. 3E