



Road to Decarbonization with Infineon

Commercial air conditioning and heat pump

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SEP 2023



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Commercial HVAC systems, serving power ranges from 5 kW to several megawatts, can keep temperatures comfortable, the humidity consistent, and the indoor air quality high.

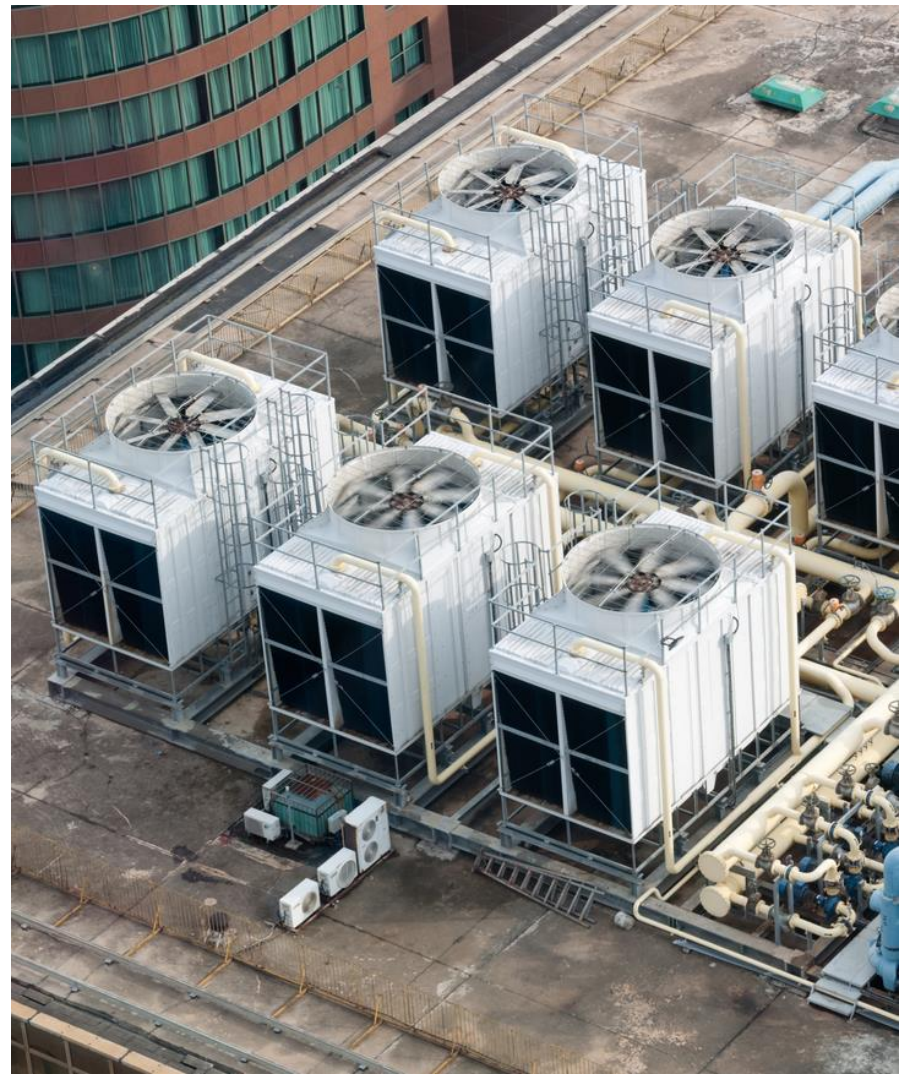
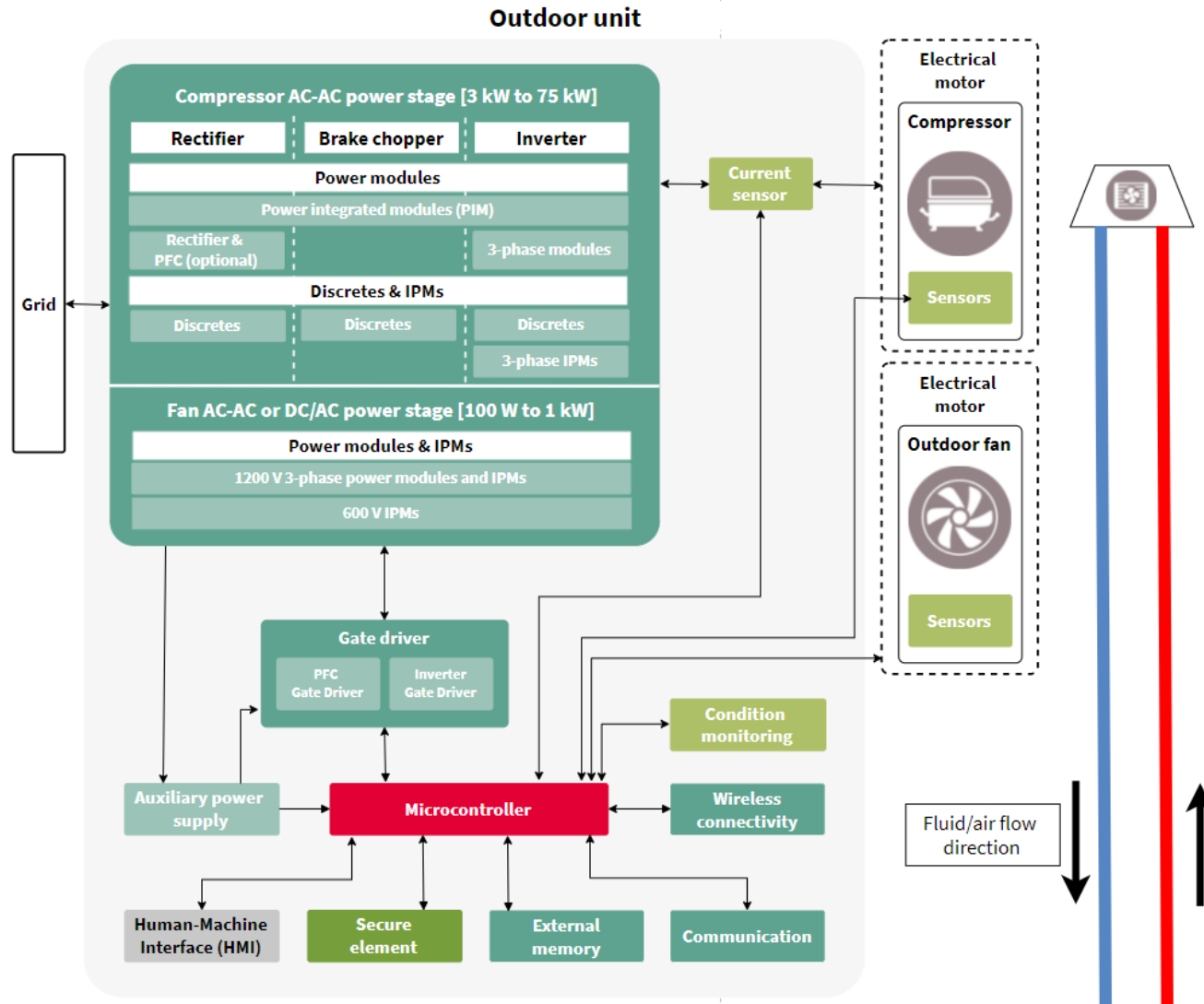
Infineon offers the optimal products for your C-HVAC, specially designed for larger commercial and industrial buildings such as hospitals, hotels, factories, or multi-level offices.

Efficiency

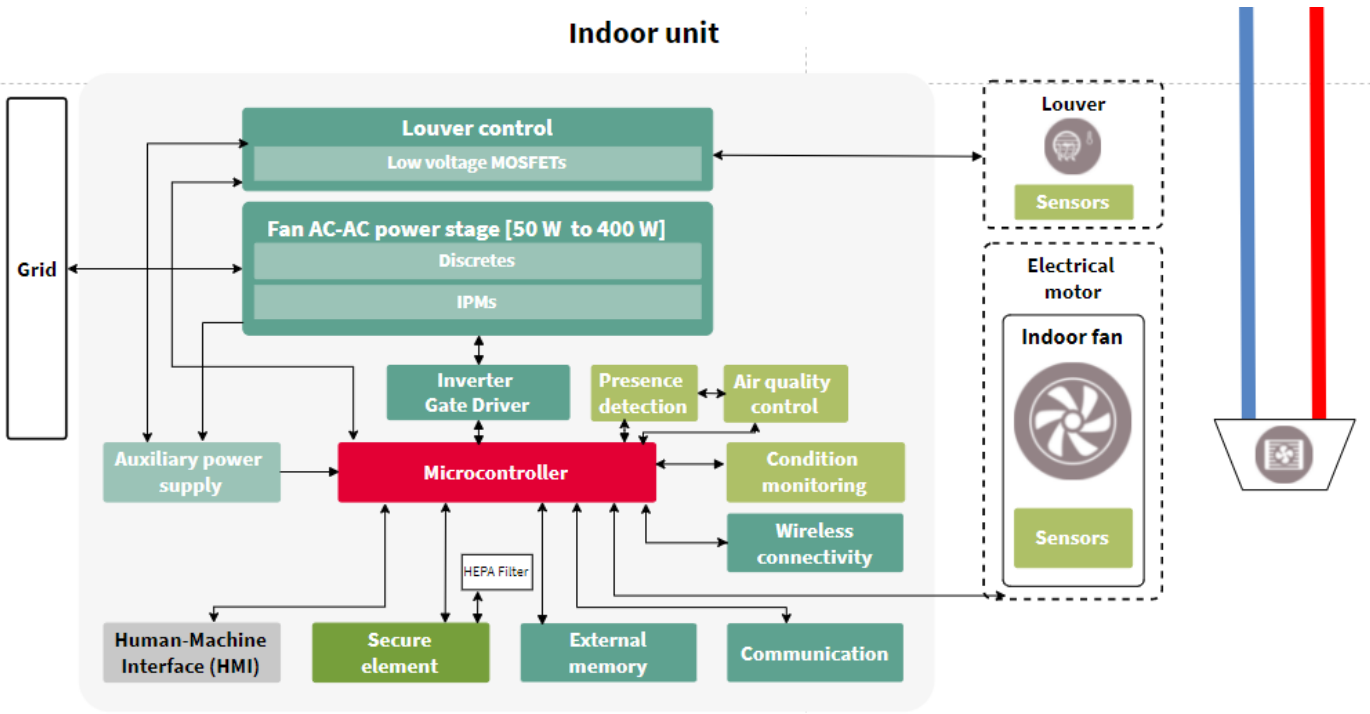
IGBT3 IGBT4 IGBT7 IGBT8 SiC



System block diagram – Outdoor unit



System block diagram – Indoor unit



Infineon's comprehensive product range for C-HVAC applications

Microcontroller

- XMC™
- iMOTION™ motor control
- PSoC™ 4 & PSoC™ 6

Power stage

- Easy Power Modules
- EconoPIM™ 2/3
- IGBT & SiC Discretes
- Intelligent Power Modules (IPM)
- EiceDRIVER™ for SiC MOSFETs
- Gate Driver ICs for IGBTs

Sensors & Condition monitoring

- Sensor fusion reference solution with cloud connectivity
- MEMS microphones
- XENSIV™ PAS CO₂ sensor
- Magnetic sensors
- Integrated shunts
- Current sensors for automotive and industrial
- Radar sensors
- Angle Sensors

Memory

- SEMPER™ NOR Flash
- HYPERRAM™

Security

- OPTIGA™ Connect IoT - easy, flexible and secured cellular IoT connectivity
- OPTIGA™ Authenticate - verifying the authenticity of devices to enable trust
- Secured communication / secured host firmware update
- OPTIGA™ Trust M

Technologies

- CoolSiC™
- TRENCHSTOP™

Wireless

- AIROC™ wireless connectivity products, including Wi-Fi® and Bluetooth® Combos

Key market trends and drivers



Smart HVAC / Sensor function

- Intelligent monitoring of C-HVAC systems for predictive maintenance for system operators (e.g. monitoring of room temperature, health data, etc.) and for end customers (e.g. changing room temperature), CO₂ and radar sensing.



Urbanization and global warming

- Urbanization is still in an early stage in developing countries with a lot of potential for new buildings with demand for air conditioning and ventilation. The HVAC industry is focusing more and more on sustainable technology to make its contribution to the environment, which includes e.g. the use of solar panels and geothermal heating and cooling to reduce energy costs.

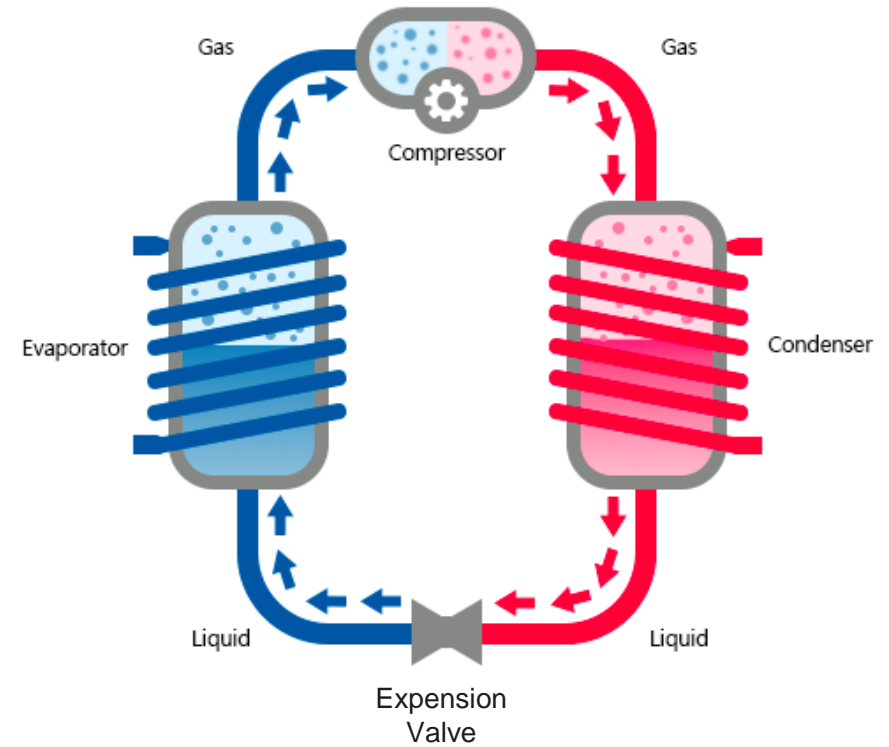
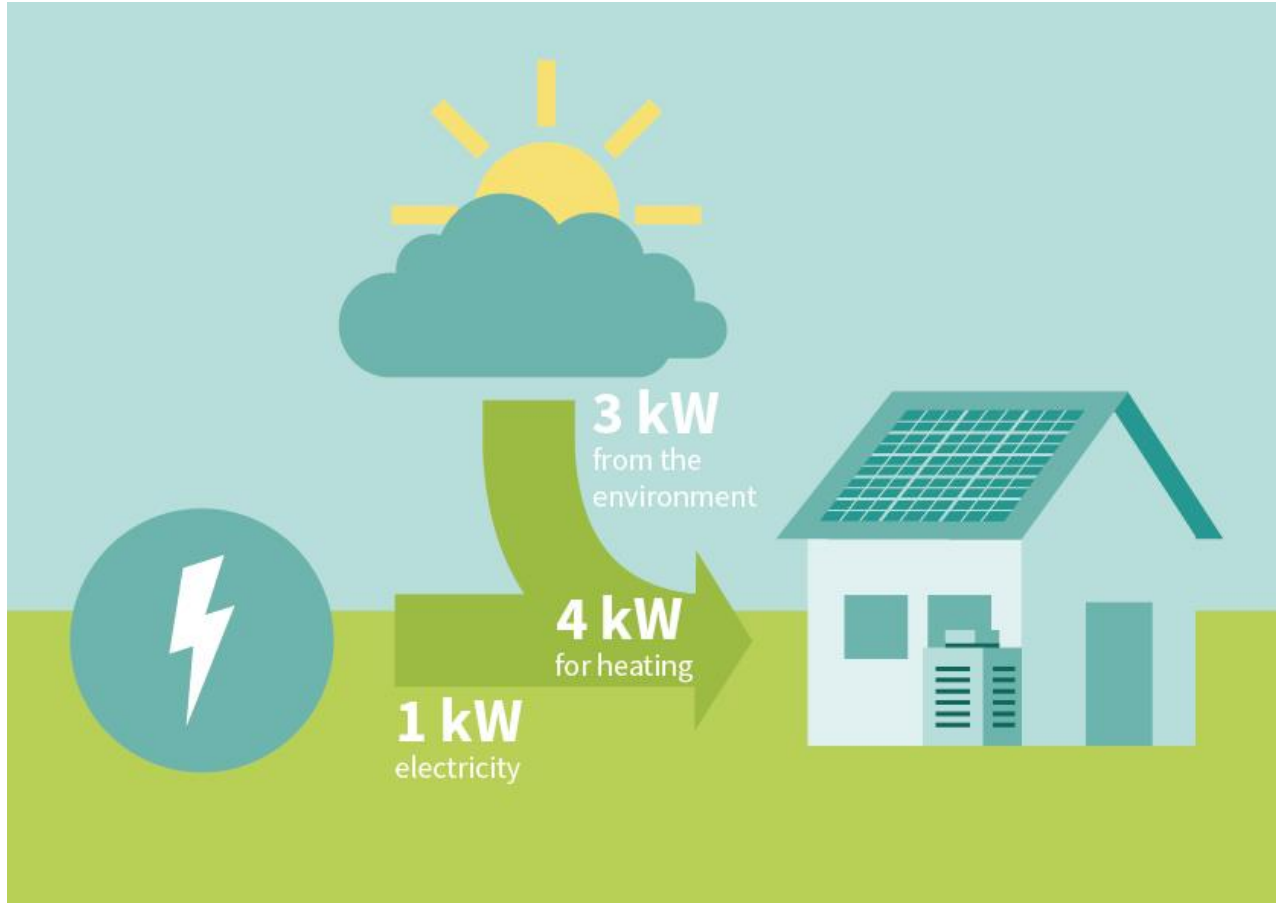


Stringent environmental legislation and fundings

- Strive toward green and other energy efficiency goals that reduce carbon footprints and achieve corporate sustainability goals.

Heat pump as key engine for decarbonization

The magic of the heat pump lies in its ability to move heat from the environment, not in creating it. „Energy is all round us“



Electricity is not used to generate heat, but to move energy from the environment!


Get a grasp on the market size and the usage of the measure kW

Passive house




150 sqm: <1 kW*

New building, standard isolation




150 sqm: <4 kW*

Renovated old building



150 sqm: <6 kW*

Old building



150 sqm: <9 kW*

*Max electrical power

Facts and figures heat pump

- Heat pump market size today: ~10m pcs
- EU objective: 60m heat pumps added by 2030 (REpower)
- 130m buildings in Europe (110m family homes)
- 113m buildings in the US (102m family homes)
- Average lifetime of heat pump: 15-20 years
- At the moment, 20m HPs installed in EU

There are three ways to use kW in HP

- Heating Capacity
 - The amount of heat generated by the heat pump
- Electrical power in operation (A7/W35)
 - Power required to heat up water to 35°C at an outdoor temperature of 7°C
- Maximum electrical power
 - Maximum power that can be provided by the system

The heat pump market is hot – More than €4bn investment announced in 2022 alone



Bloomberg

Carrier to Buy Viessmann Climate Solutions Unit for €12 Billion

2

Eyk Henning and Aaron Kirchf

Tue, April 25, 2023 at 11:12 PM GMT+2

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Midea starts work on new heat pump plant in Italy

By QIU QIANLIN in Guangzhou | China Daily | Updated: 2022-10-15 08:25

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13:03

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Unternehmen

03.05.22

WÄRMEPUMPEN

Viessmann investiert historische Summe

Familienunternehmen wendet eine Milliarde Euro auf.



BEITRAG TEILEN

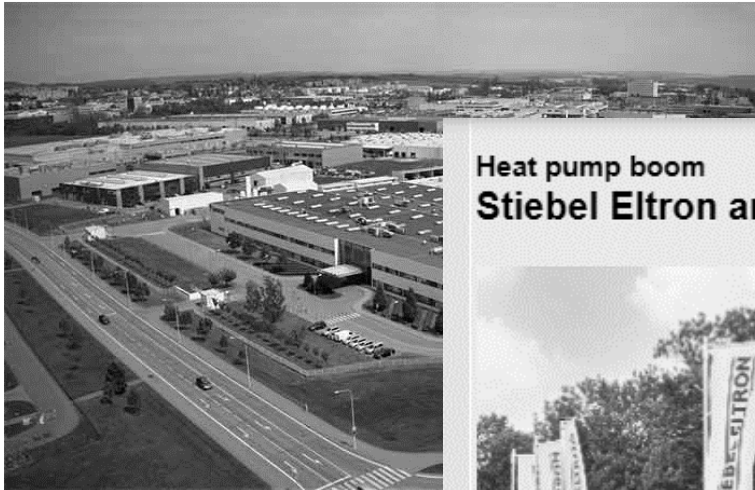


MERKEN

The New York Times

€50m boost for Brno heat pump plant

19 OCT 2022



BELGIUM: Daikin Europe has announced a €50m investment in

Heat pump boom Stiebel Eltron announces investments of 600 million euros



Holzminden - As early as 2021, almost 30 p more heat pumps were installed in Germany 2020 in a dynamic market environment with devices than in 2020.

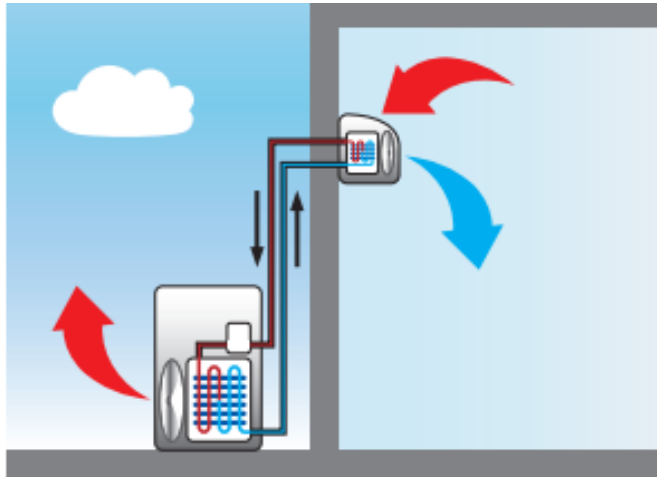
In the course of the turmoil on the gas mark representatives now expect an even larger j

An Oily Challenge: Evict Stinky Old Furnaces in Favor of Heat Pumps

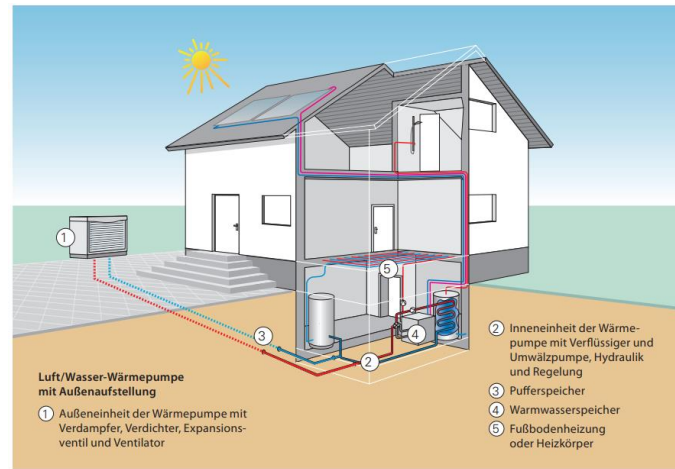
Building by building, New York and other cities are trying to stop the age-old use of fossil fuels to heat homes and buildings. In the U.S., new climate laws aim to speed things up

Overview heat pump systems: Air-to-water most prevalent in Europe, air-to-air most prevalent in the US

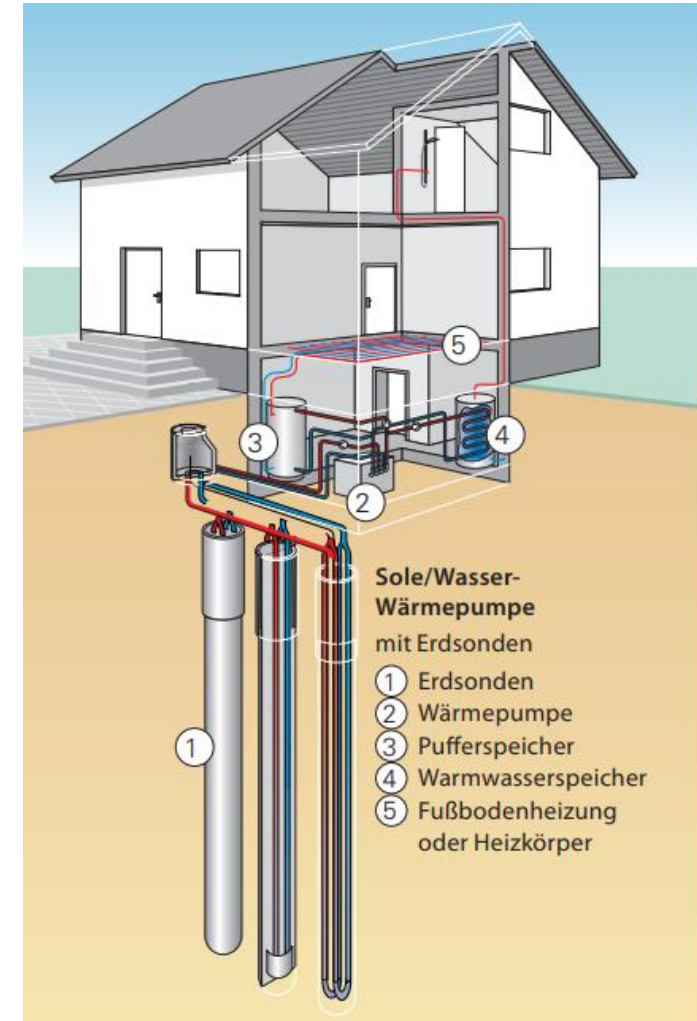
Air-to-air heat pump



Air-to-water heat pump



Brine-to-water heat pump



85% of the market

Basic principle of a heat pump is the heat transfer from a heat source to a heat sink.

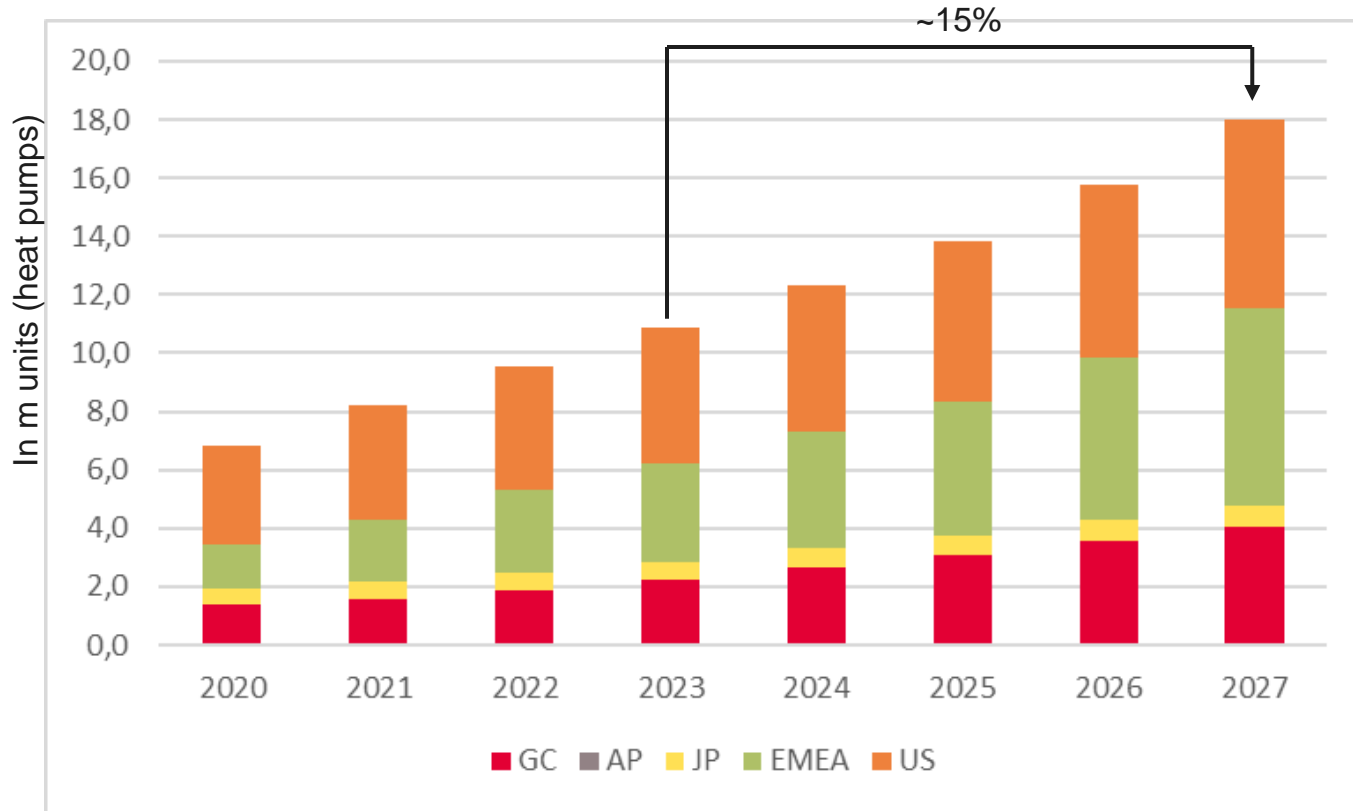
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Residential heat pump market in Europe will grow by ~20% over the next years, global growth is estimated to be ~15%



Market TAM



Sources: European Heat pump association (EHPA), AHRI and China IOL

Market observations

US: In 2020, air-source heat pumps surpassed gas furnaces for the first time.

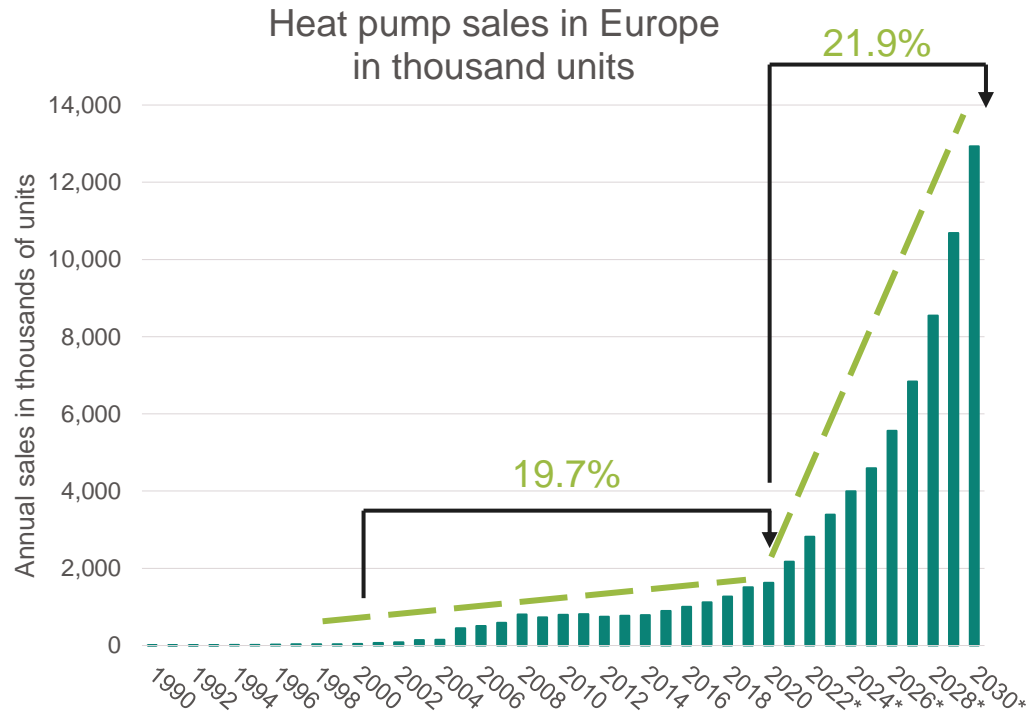
Europe: 3m units in 2022. EU objective to have 60m installed heat pumps by 2030 results in high CAGR of ~20%

Japan: Domestically residential air-conditioning (multi-split air-to-air) is used.

China: Heating typically via residential air-conditioning. Main growth seen in export market. Local policies to subsidize heat pumps expected soon.

Net-zero target and new regulatory frameworks result in high growth, in particular in Europe

Heat pump market in **Europe** has been growing at 20% CAGR for the past 20 years. It is expected to grow even faster due to new regulations.



Source: European Heat Pump Association, 2022

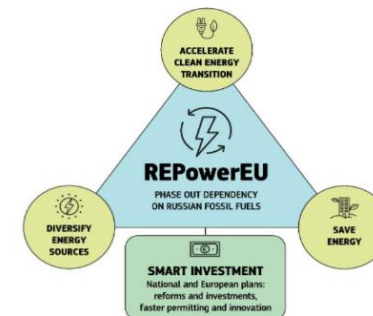
REPowerEU creates massive demand for heat pumps in Europe.

Objective: Independence from Russian fossil fuels.

Amongst the set of actions: Replace gas in heating systems.

How? Stricter eco design rules and increased energy saving targets.

Estimation of total heat pumps necessary by 2030: 60 million installed heat pumps.



EU Net-Zero Industry Act: Aims to scale up production of heat pumps in Europe - Heat pumps are a strategic technology



Brussels, 16.3.2023
COM(2023) 161 final

ANNEX

ANNEXES

to the

**proposal for a Regulation of the European Parliament and of the Council
on establishing a framework of measures for strengthening Europe's net-zero
technology products manufacturing ecosystem (Net Zero Industry Act)**

ANNEX

STRATEGIC NET-ZERO TECHNOLOGIES

1.	Solar photovoltaic and solar thermal technologies
2.	Onshore wind and offshore renewable technologies
3.	Battery/storage technologies
4.	Heat pumps and geothermal energy technologies

Market research – Focus: USA

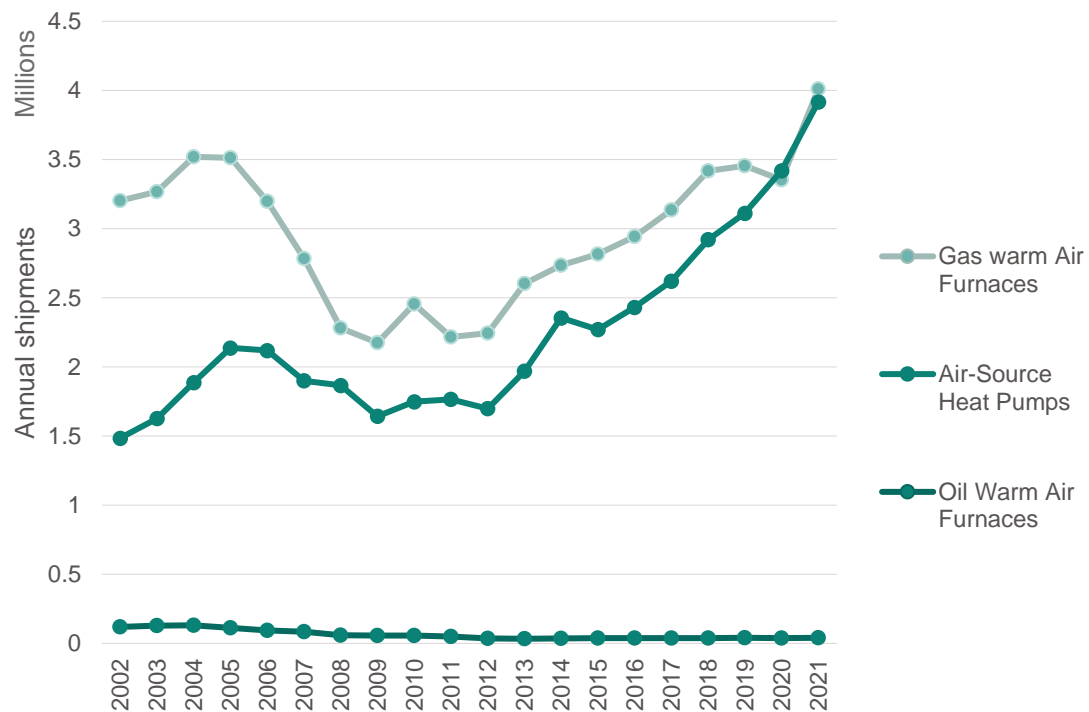
In 2020 heat pumps surpassed gas furnaces for the first time –
But: Low inverterization rate (<10%)

US Inflation Reduction Act offers tax credits to home builders and
owner who install heat pump

Regulatory changes in 2024 (SEER 15) and 2029 (SEER 18).

Inverterization will remain low for the next years without regulation, as gas is
much cheaper than electricity.

Annual shipments in the USA from 2001 to 2021

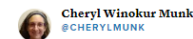


Source: Air-Conditioning, Heating & Refrigeration Institute

ESG IMPACT

Heat pumps are an energy upgrade for homeowners that's becoming a climate and financial winner

PUBLISHED SAT, DEC 10 2022-10:00 AM EST



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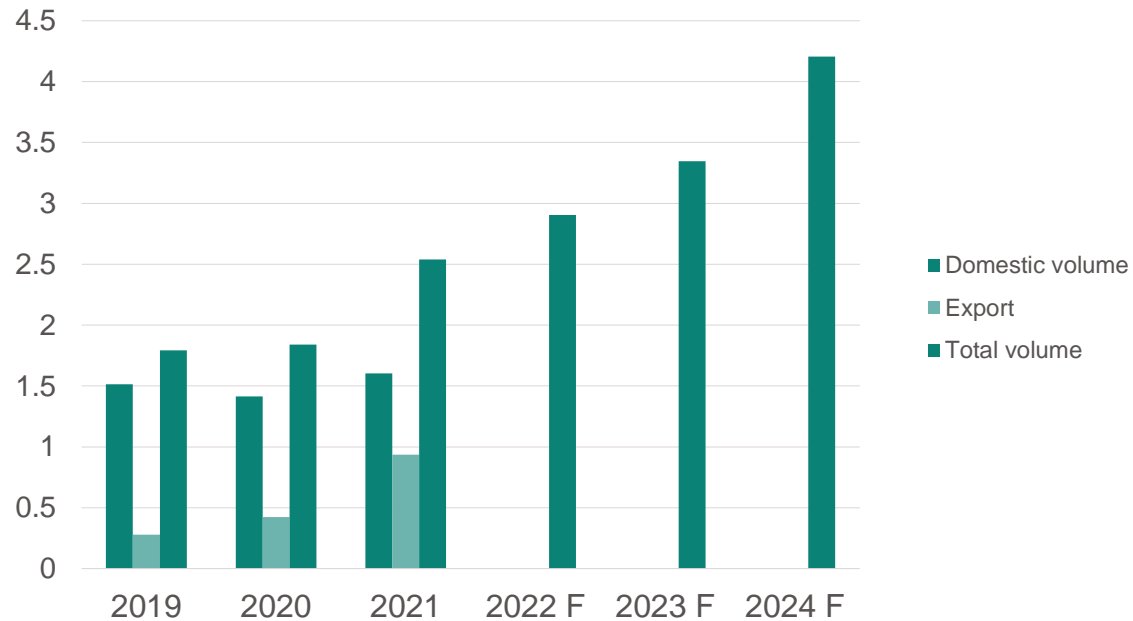
Bloomberg

China is a major supplier of inverters to European heat pump makers – and a source of future growth!

Total market growth of ~20% CAGR expected

The inverterization rate for heat pumps is still below 50% in China

China air-source heat pump volume in mio units



Many European heat pump companies still purchase inverter from Chinese inverter makers, some purchase entire “white label” heat pumps.

Largest usage locally in sanitary hot water.

Local growth expected due to potential upcoming regulation in southern China.

Source: ChinaIOL

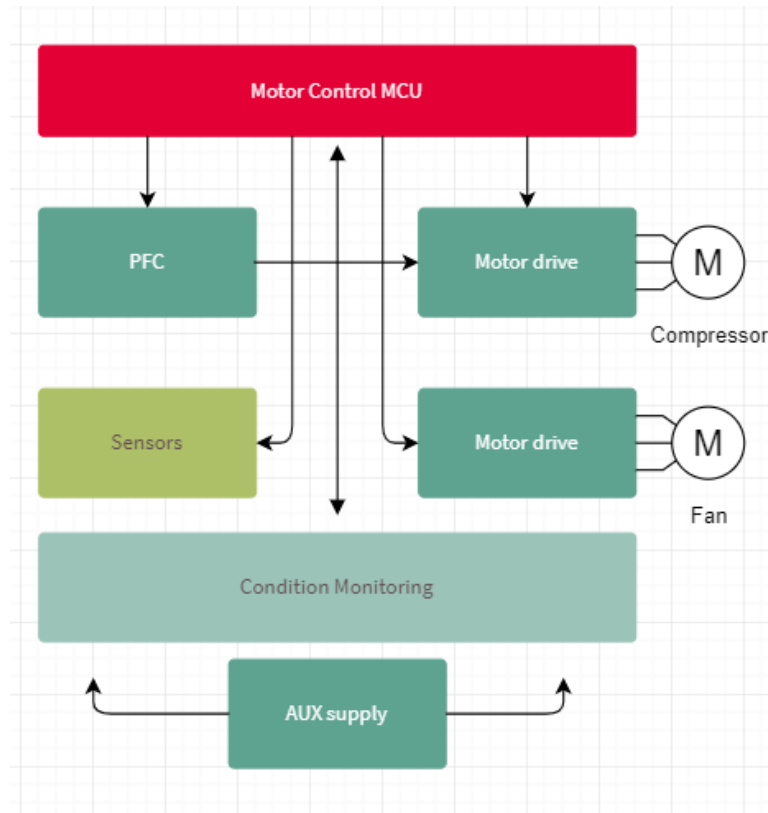
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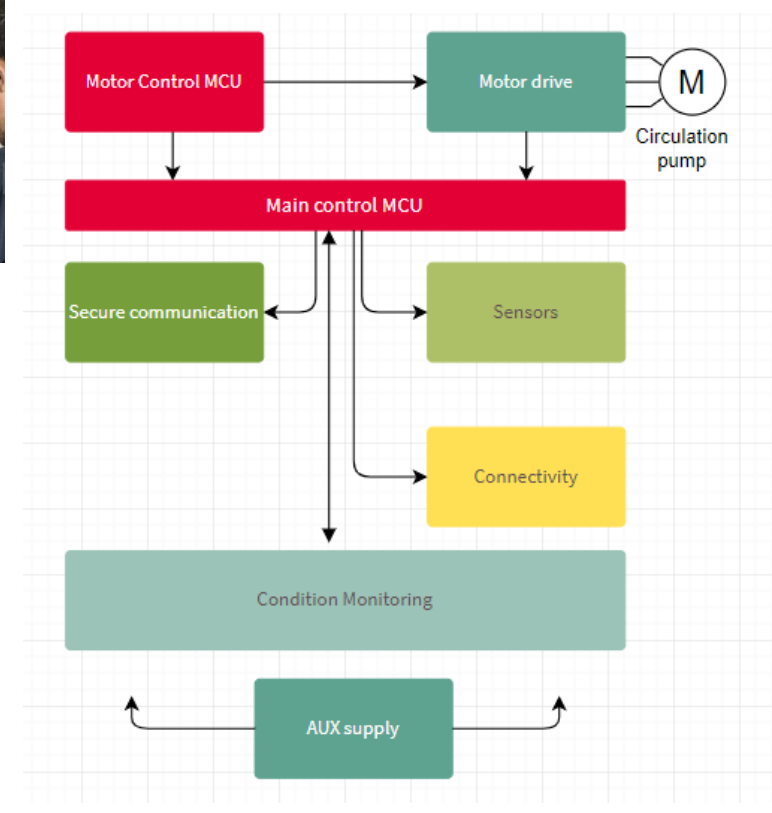
Block diagram for a split cell heat pump: Infineon offers the entire portfolio to develop smart and efficient heat pumps



Outdoor Unit






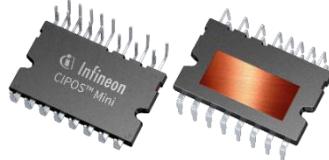


Indoor Unit



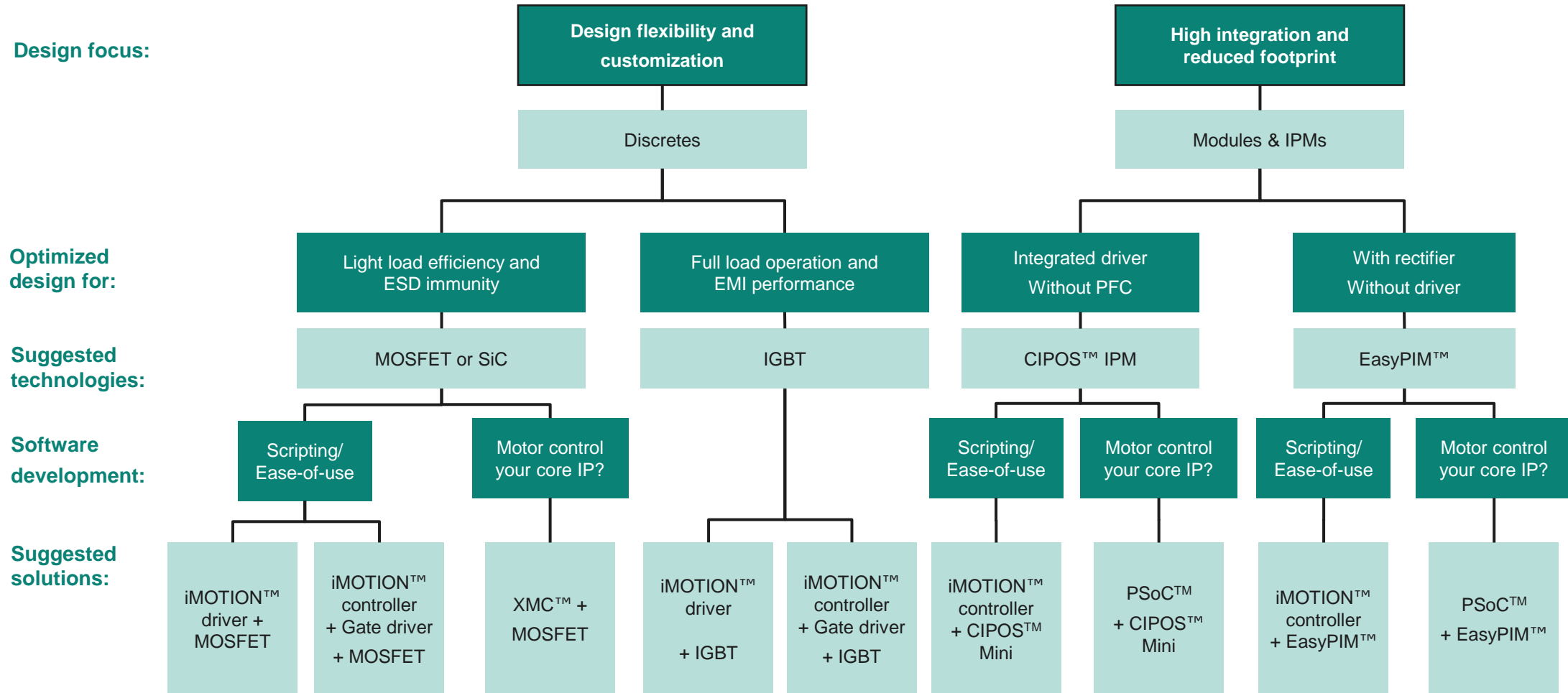
Split systems are very common for new buildings, monobloc systems are more common in retrofits.
The system blocks, however, are almost identical.

Infineon offers different ways of implementing compressor drives across all power classes.



Power level compressor	MCU	Gate driver	Power switch	Infineon product families	
low < 5 kW	PSoC™ 6/ XMC™	EiceDRIVER™	Si IGBT/ SiC MOSFET		
	iMOTION™ driver (IMD110)		Si IGBT/ SiC MOSFET		
	iMOTION™ controller (IMC 100 and 300)	CIPOST™ IPM			
	PSoC™/ XMC™	EiceDRIVER™	EasyPIM™		
	iMOTION™ driver (IMD110)				
high > 5 kW	PSoC™/ XMC™	EiceDRIVER™	Si IGBT/ SiC MOSFET		
	iMOTION™ driver (IMD110)		Si IGBT/ SiC MOSFET		
	PSoC™/ XMC™	EiceDRIVER™	EasyPIM™		
	iMOTION™ driver (IMD110)				

Infiniteon offers solutions from low to high integration - It's your choice



Power factor correction – Topologies in heat pump systems



Criteria \ Topology	CCM Boost PFC		CCM Interleaved PFC		Totem-pole PFC		Vienna Rectifier		Sixpack active front end	
Suitable power range	– Suitable for > 1.5 kW – 1-phase and 3-phase		– Suitable for > 2.5 kW – 1-phase and 3-phase		– Suitable for > 2.5 kW – 1-phase and 3-phase		– Suitable for > 2.5 kW – 3-phase		– Suitable for > 2.5 kW – 3-phase	
Cost	– Moderate cost		– High cost for low power		– Affordable for high power		– Moderate cost		– Affordable for high power	
Switching frequency	– High switching frequency – Low harmonics		– High switching frequency – Low harmonics		– High switching frequency – Low harmonics		– High switching frequency – Low harmonics		– High switching frequency – Low harmonics	
Efficiency	– Bridge rectifier needed		– Bridge rectifier needed		– No bridge rectifier needed		– No bridge rectifier needed		– No bridge rectifier needed	
	– Meets energy regulations		– Meets energy regulations		– Meets energy regulations		– Meets energy regulations		– Meets energy regulations	
Power factor	– PF ~0.99 – Minimized harmonics		– PF ~0.99 – Minimized harmonics		– PF ~0.99 – Minimized harmonics		– PF ~0.99 – Minimized harmonics		– PF ~0.99 – Minimized harmonics	
Control	– Easy implementation – Dedicated controller available		– Easy implementation – Dedicated controller available		– Slightly complex than ordinary boost PFC, and no dedicated controller available		– Easy implementation – Dedicated controller available		– Slightly complex than ordinary boost PFC, and no dedicated controller available	
Form factor	– Smaller form factor		– Smaller form factor		– Smallest form factor		– Smaller form factor		– Smallest form factor	

Reference design proposal: Total system solution for 5 kW heating power



Power components		Connectivity	Value proposition
PFC & Compressor PFC: 1-phase system CCM Boost converter Compressor: $P_{max} < 2500 \text{ W}$	<ul style="list-style-type: none"> – iMOTION™ Controller IMC302 – CIPOS™ Mini with integrated PFC stage (IM564) – EiceDRIVER™ 1ED44175 	AIROC™ Wi-Fi + Bluetooth® Combos	<ul style="list-style-type: none"> – Highest integration and power density – Compact and easy to design-in – Faster time-to-market
		Security	
		OPTIGA™ Trust	
		System Control / HMI	
		PSoC™ 6/ CAPSENSE™	
Fan $P_{max} < 200 \text{ W}$	<ul style="list-style-type: none"> – iMOTION™ Controller (IMC101T for fan only, IMC303 for dual motor) – CIPOS™ Micro 	Sensors	
Pump $P_{max} < 100 \text{ W}$	<ul style="list-style-type: none"> – iMOTION™ Controller – CIPOS™ Micro/Nano – Integrated iMOTION™ IPM 		
Auxiliary power supply		<ul style="list-style-type: none"> – XENSIV™ PAS CO2 sensor – XENSIV™ MEMS microphone – XENSIV™ Radar sensing 	<ul style="list-style-type: none"> – XENSIV™ Current sensors – XENSIV™ Hall sensors – XENSIV™ Pressure sensors
CoolSET™ 5 th generation			

Reference board for 1-phase compressor drive up to 2.5 kW: REF-AIRCON-C302A-IM564

REF-AIRCON-C302-IM564 is a 3-phase turnkey motor drive for air conditioner outdoor units (ODU).



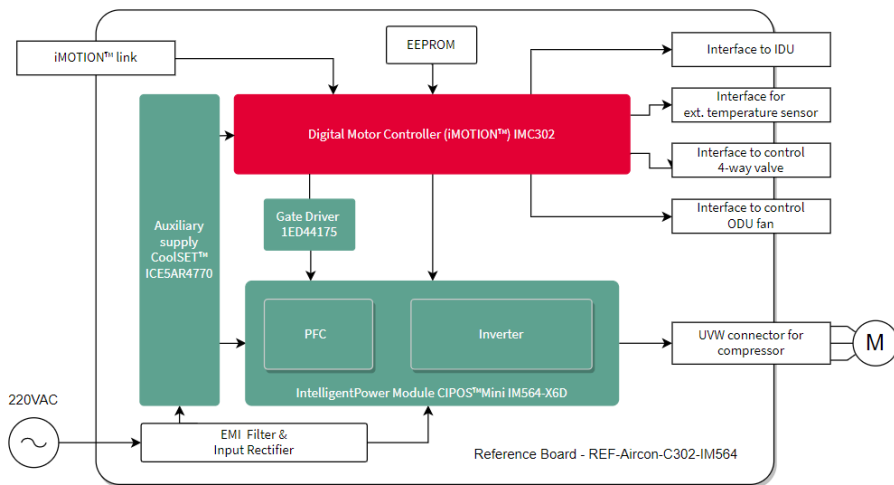
Components:

- iMOTION™ controller,
- CIPOS™ Mini IPM with integrated PFC stage
- EiceDRIVER™ gate driver for the PFC stage
- CoolSET™ for the auxiliary supply

Input	P _{out} max	Dedicated application
230 V 1/ PN/ 50 Hz	2500 W	Inverter for compressor

Benefits

- Excellent PFC performance (PF = 0.999 and THD = 3.4% measured for 1400 W)
- Up to 15% PCB space savings compared to the discrete implementation
- Ready-to-use motor control algorithms (incl. PFC) for high-efficiency permanent magnet synchronous motors (PMSM)



Reference design proposal: Total system solution for up to 13 kW heating power



Power components		Connectivity	Value proposition
PFC & Compressor PFC: 1-phase system CCM interleaved Boost converter Compressor: Pmax < 5000 W	<5kW inverter and discrete PFC – Inverter with EasyPIM™ FB30R06W1E3 and EiceDRIVER™ 2EDL23I06PJ – PFC with EiceDRIVER™ 1ED44175, IDW60C65D1, IKW40N65WR5 – iMOTION™ Controller IMC302 <7kW inverter & integrated PFC – EasyPIM™ -FB50R07W2E3_B23 with EiceDRIVER™ 2EDL23I06PJ	AIROC™ Wi-Fi + Bluetooth® Combos	– Highest integration and power density – Compact and easy to design-in – Faster time-to-market
		Security	
		OPTIGA™ Trust	
		System Control / HMI	
		PSoC™ 6/ CAPSENSE™	
Fan Pmax < 300 W	– iMOTION™ Controller IMC1xx – CIPOS™ Micro/Mini		
Pump Pmax < 100 W	– iMOTION™ Controller IMC 1xx – CIPOS™ Micro or – Integrated iMOTION™ IPM		
Auxiliary power supply		Sensors	
CoolSET™ 5 th generation		– XENSIV™ PAS CO2 sensor – XENSIV™ MEMS microphone – XENSIV™ Radar sensing	– XENSIV™ Current sensors – XENSIV™ Hall sensors – XENSIV™ Pressure sensors

Reference design proposal: Total system solution for 3-phase 18 kW heating power



Power components		Connectivity	Value proposition
PFC 3-phase active front-end	<ul style="list-style-type: none"> – Vienna rectifier module FS3L35R07W2H5_C40 	AIROC™ Wi-Fi + Bluetooth® Combos	<ul style="list-style-type: none"> – Discrete solution for PFC – Design flexibility & high efficiency – Integrated solution for fan and pump – Module solution for compressor – High Energy Density – Faster time-to-market
Compressor P _{max} < 7000 W	<ul style="list-style-type: none"> – iMOTION™ Controller – IGBT module FP35R12N2T7 – Inverter & integrated PFC (Vienna) FP35R12N2T7_B67 	Security	
Fan P _{max} < 1000 W	<ul style="list-style-type: none"> – iMOTION™ Controller – CIPOS™ Maxi (IM818) 	OPTIGA™ Trust	
Pump P _{max} < 500 W	<ul style="list-style-type: none"> – iMOTION™ Controller – CIPOS™ Micro 	System Control / HMI	
		PSoC™ 6/ CAPSENSE™	
Auxiliary power supply		Sensors	
CoolSET™ 5th generation		<ul style="list-style-type: none"> – XENSIV™ PAS CO2 sensor – XENSIV™ MEMS microphone – XENSIV™ Radar sensing 	<ul style="list-style-type: none"> – XENSIV™ Current sensors – XENSIV™ Hall sensors – XENSIV™ Pressure sensors

How Infineon products make heat pumps better, more efficient and the developer's life easier



Compressor	Easy and Econo modules are the swiss army knife for heat pumps: Inverter and PFC across all power classes. The most reliable solutions from the market leader with the largest capacity and the fastest customization process. Infineon modules can be driven with EiceDRIVER™ gate drivers
Fans and pumps	Speed up time-to-market with our easy-to-use smart IPMs: Integrated controller and power stage in a single package up to 70 W. For higher power fans and pumps, our IPM portfolio offers solutions up to 3 kW.
Connected heat pumps	Reduce development efforts from 1 year to 30 days with the Wi-Fi product that gives your customers the longest distance
Easy to use and stylish heat pumps	Work with the number 1 in the market for touch solutions. The SmartSense tool makes developing HMI easy as never before.
The most efficient heat pump	Heat pumps hardly ever run in full load. That is where SiC comes in. Infineon's SiC solution offers the lowest RDS_{on} and the highest robustness.
Motor control made easy	Controlling compressors in heat pumps can be complex. High pressure start-up and low vibration are just two requirements and with Infineon's iMOTION™ controllers you can do just that without coding.
Design degrees of freedom	Modules for highest power requirements, IPMs for high integration requirements and best-in-class gate drivers and switches with multi-sourcing options and design flexibility.

Module solutions for heat pumps – Single Phase 230V

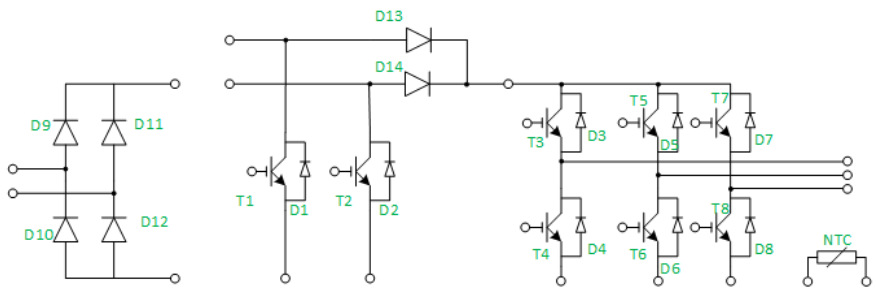
All-in-one solution (PFC and inverter) for heat pumps up to 7 kW



FB50R07W2E3_B23

High speed H5 technology for PFC

Two channel interleaved PFC



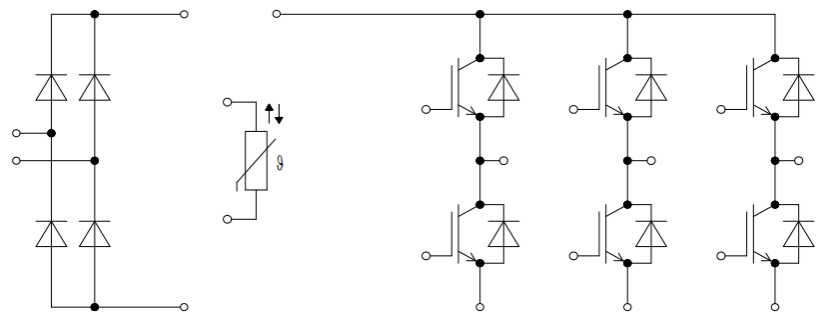
Inverter solution for heat pumps up to 5 kW



FB30R06W1E3

Very compact module (1B)

Low switching losses



Module solutions for heat pumps – Three Phase 400V

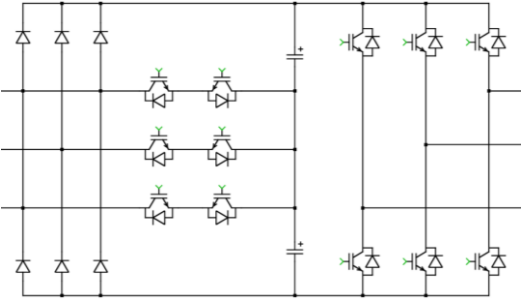
All-in-one solution (PFC and inverter) for heat pumps up to 7 kW



FP35R12N2T7_B67

High speed H5 technology for PFC / IGBT7 for inverter

Vienna PFC



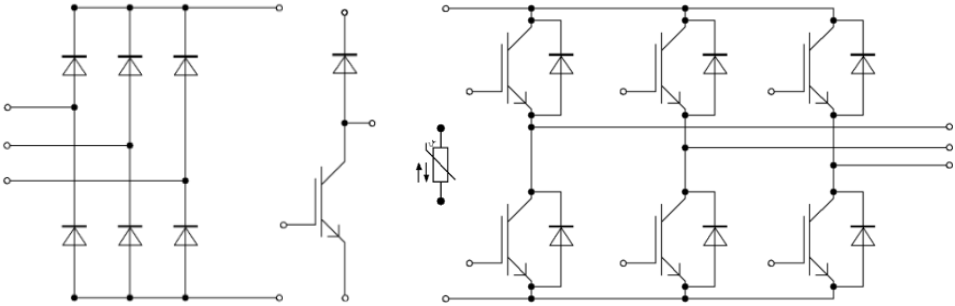
Inverter solution for heat pumps up to 5 kW



FP35R12N2T7

Baseplate module with excellent thermal performance

Low switching losses with IGBT7



Road to Decarbonization with Infineon

Q&A



Scan here to ask questions

