

Road to Decarbonization with Infineon

Commercial air conditioning and heat pump

Bryan Song

SEP 2023

restricted

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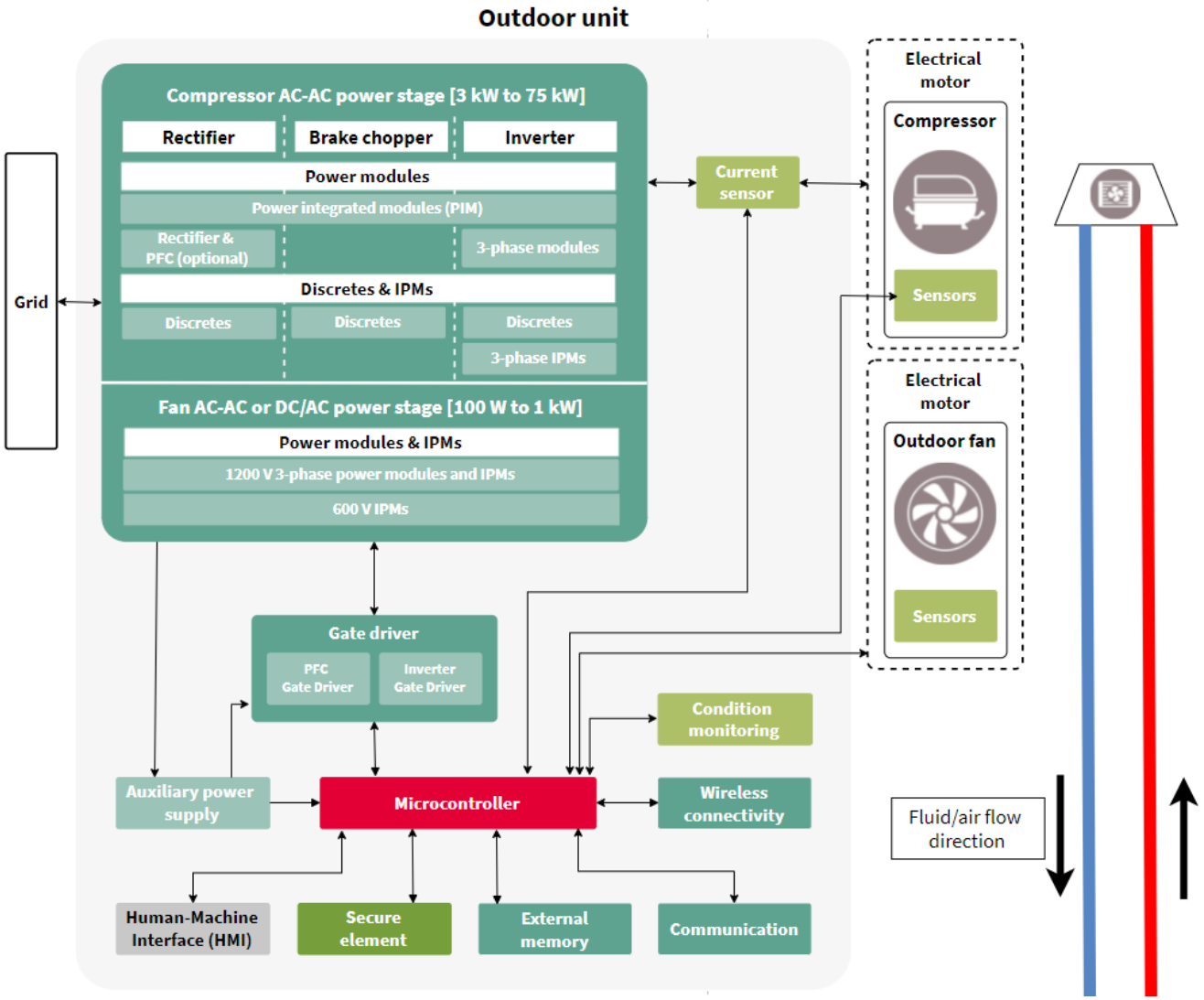
Commercial HVAC systems, serving power ranges from 5 kW to several megawatts, can keep temperatures comfortable, the humidity consistent, and the indoor air quality high.

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



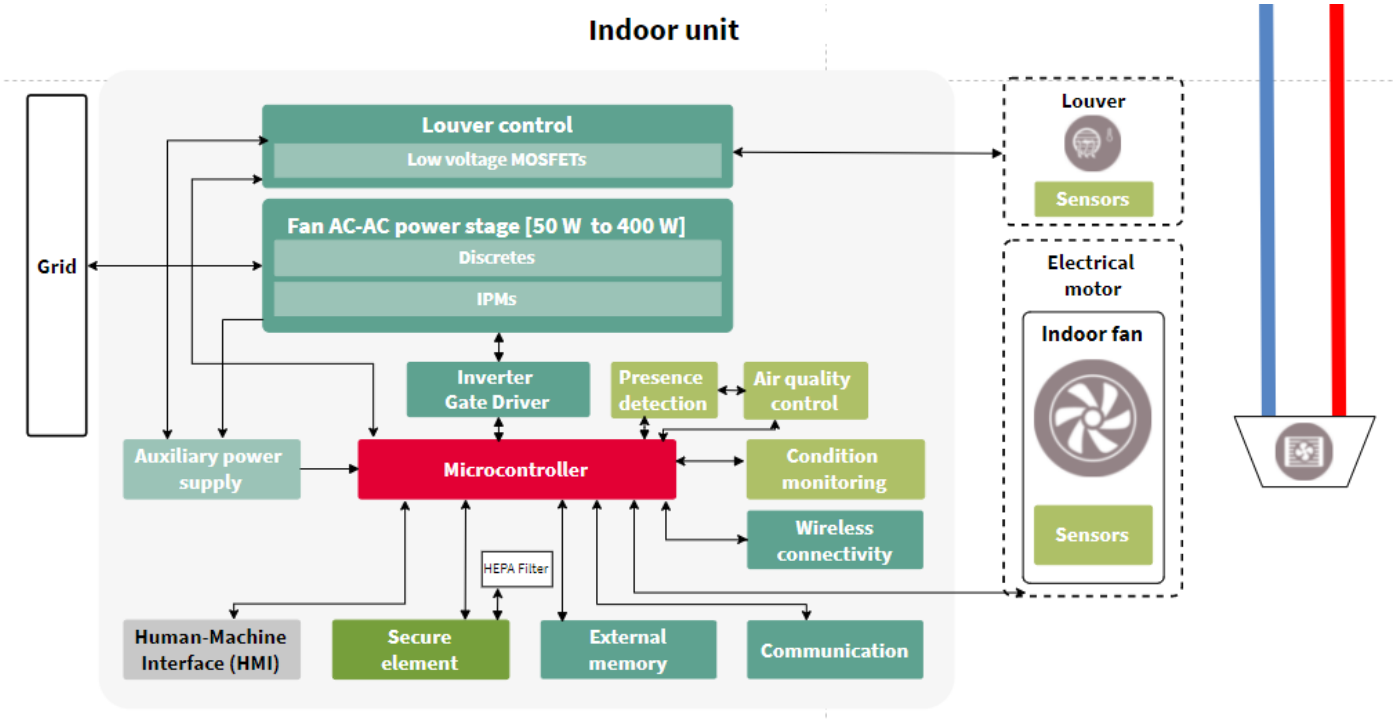
System block diagram – Outdoor unit

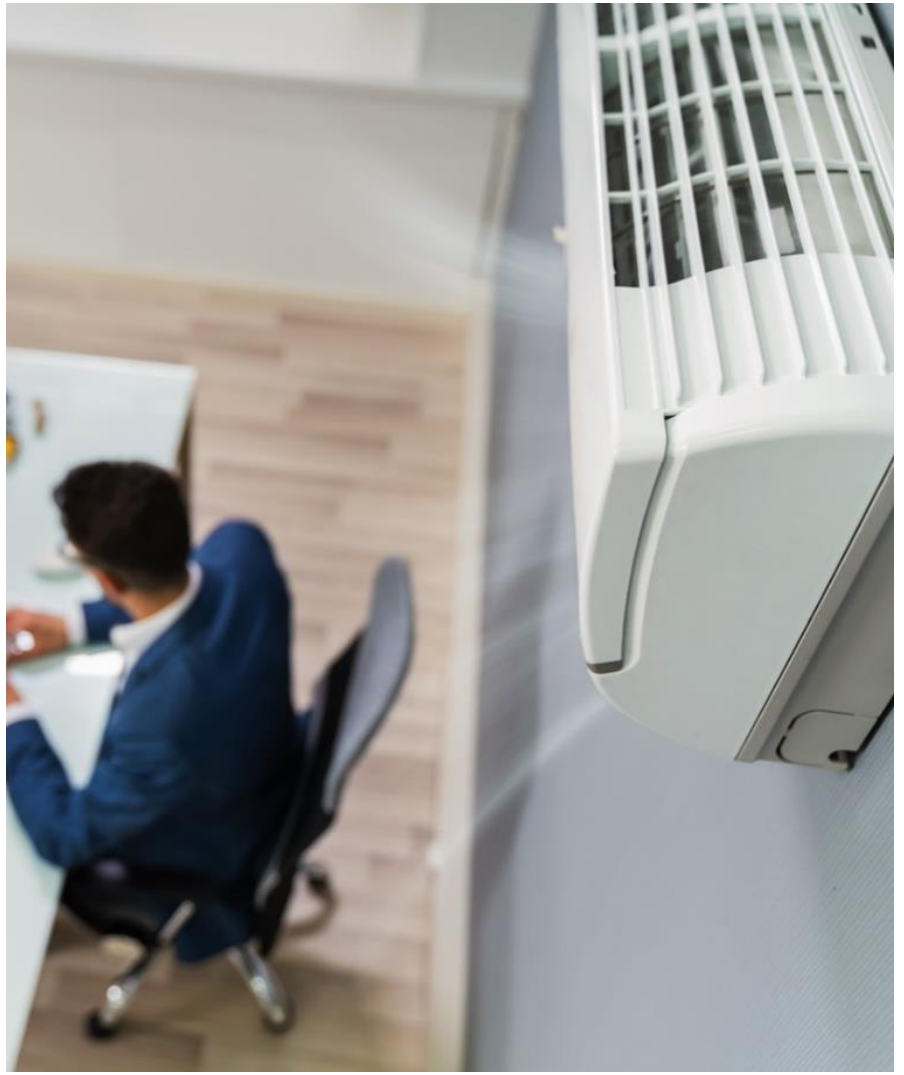




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System block diagram – Indoor unit





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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 CO_2 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

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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), CO_2 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.



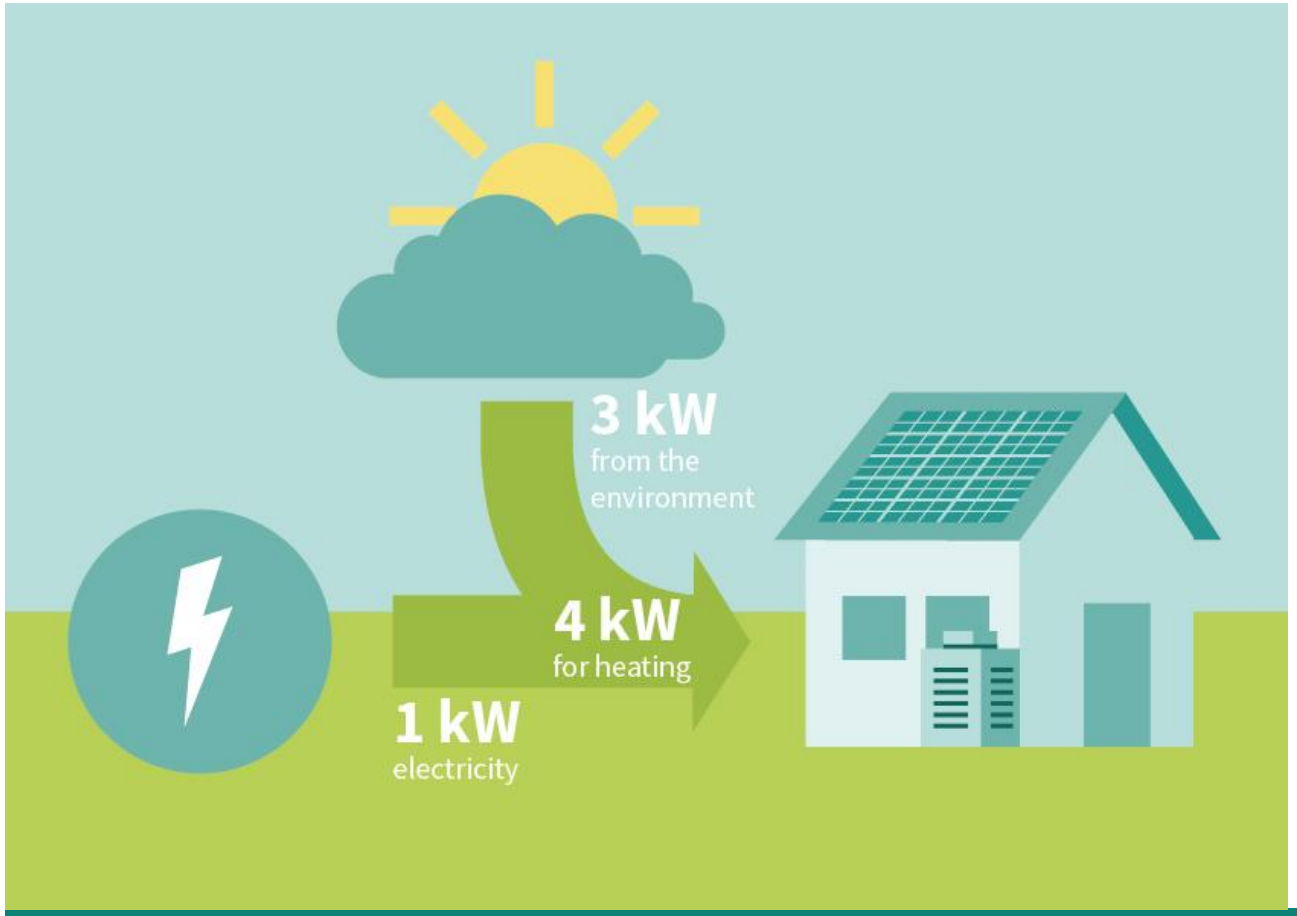
Stringent environmental legislation and fundings

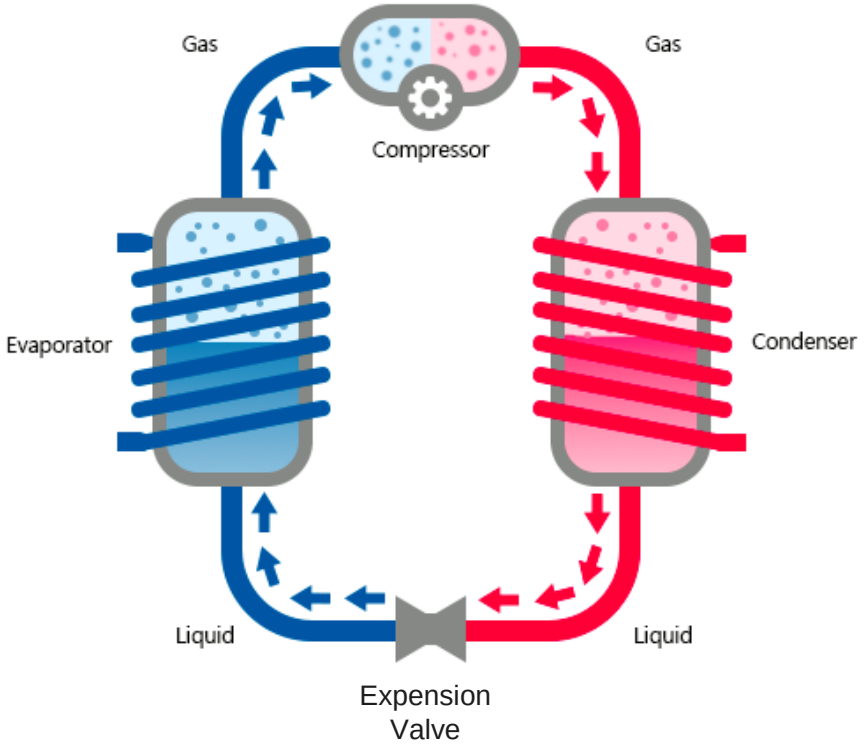
– Strive toward green and other energy efficiency goals that reduce carbon footprints and achieve corporate sustainability goals.

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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!

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

Passive house	New building, standard isolation	Renovated old building	Old building
			
150 sqm: <1 kW*	150 sqm: <4 kW*	150 sqm: <6 kW*	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

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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

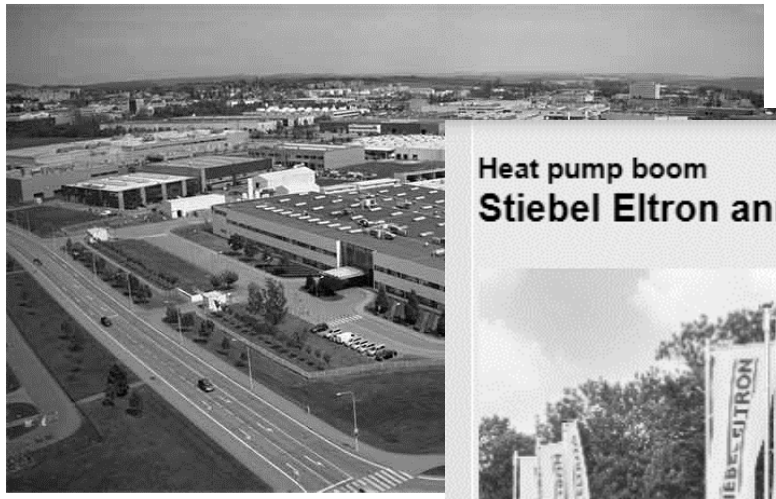
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Eyk Henning and Aaron Kirchf

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

€50m boost for Brno heat pump plant

19 OCT 2022



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

CHINADAILY.COM.CN

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Midea starts work on new heat pump plant in Italy

By QIU QUANLIN in Guangzhou | China Daily | Updated: 2022-10-15 08:35

13:03

Unternehmen 03.05.22

WÄRMEPUMPEN

Viessmann investiert historische Summe

Familienunternehmen wendet eine Milliarde Euro auf.

BEITRAG TEILEN MERKEN

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

The New York Times

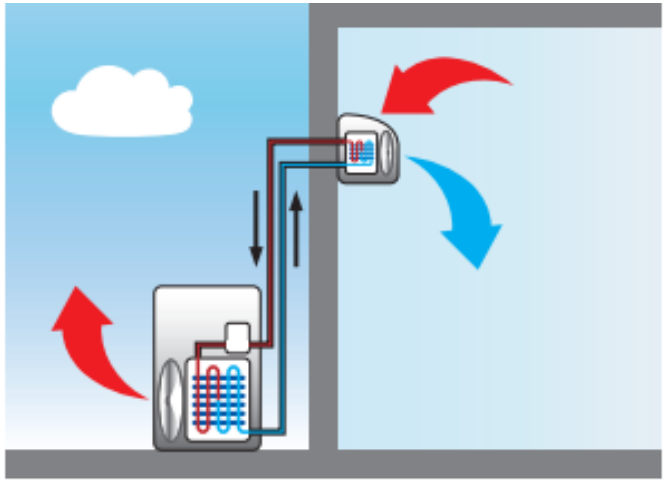
An Oily Challenge: Evict Stinky Old Furnaces in Favor of Heat Pumps

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

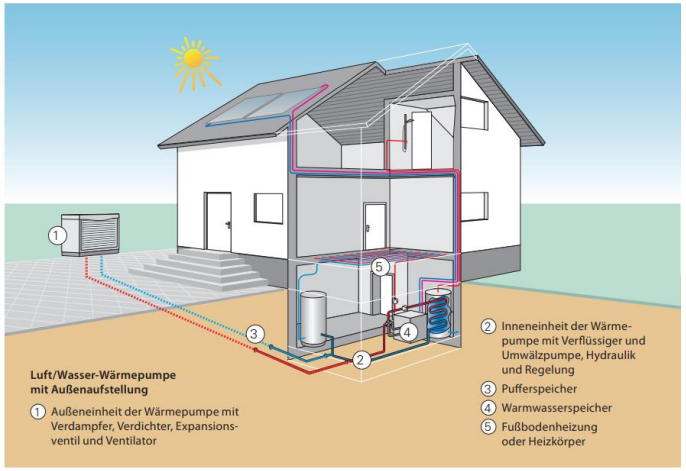
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Overview heat pump systems: Air-to-water most prevalent in Europe, air-to-air most prevalent in the US

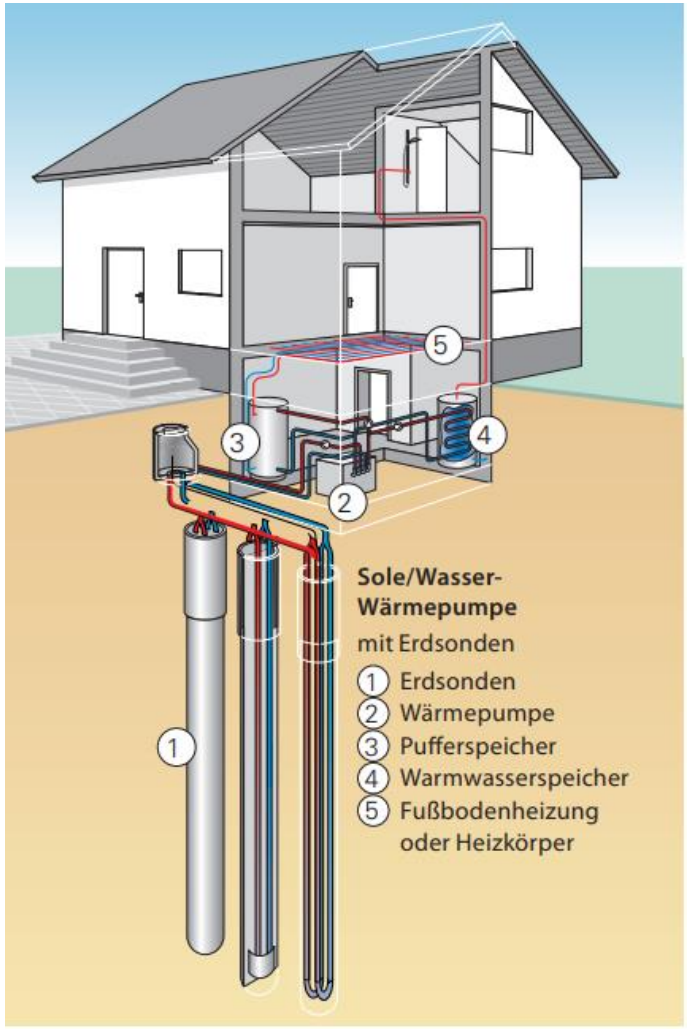
Air-to-air heat pump



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.

Source: waerme-plus.de

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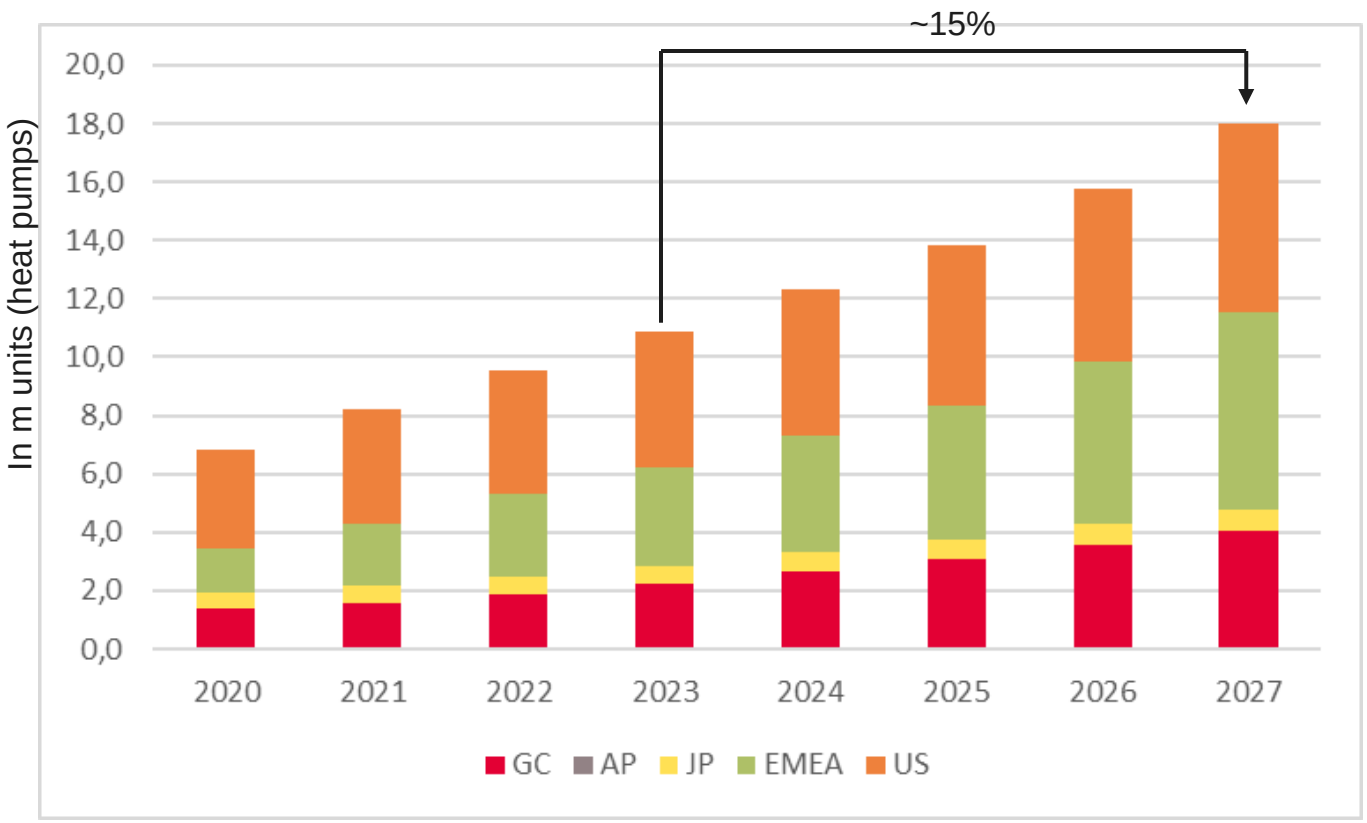
2 **Market** **13**

3 Heat pump electronics 19

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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%

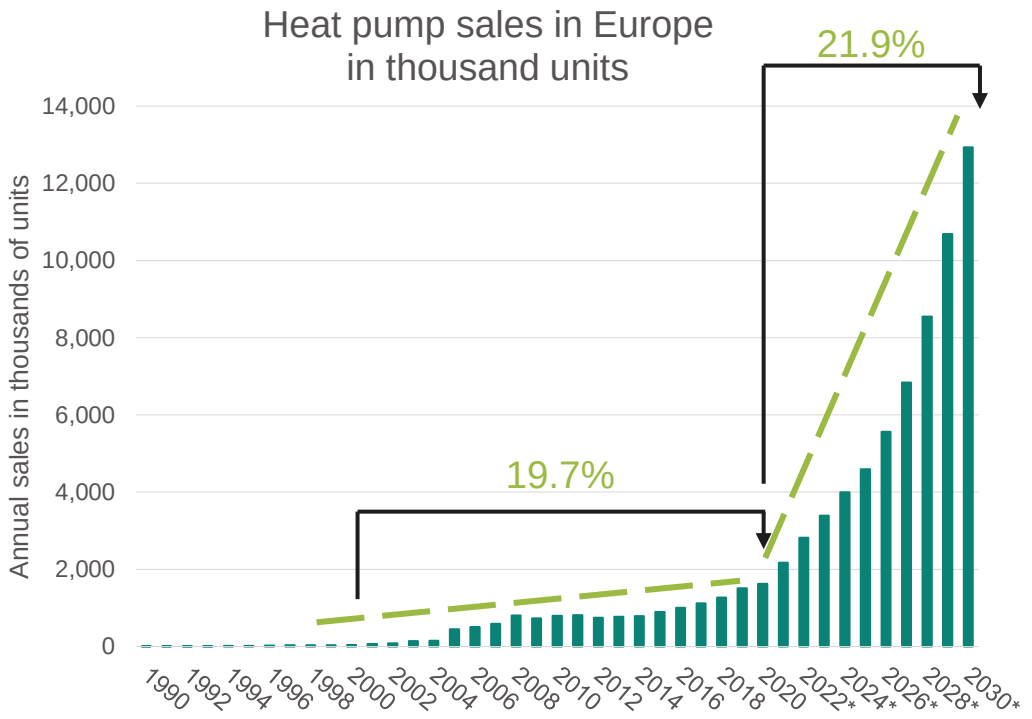
Japan: Domestically residential air-conditioning (multi-split air-to-air) is used.

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

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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

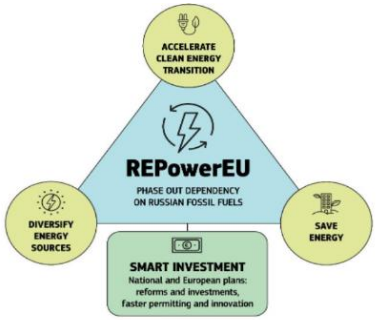
REPowerEU creates massive demand for heat pumps in Europe.

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.



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



EUROPEAN
COMMISSION

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

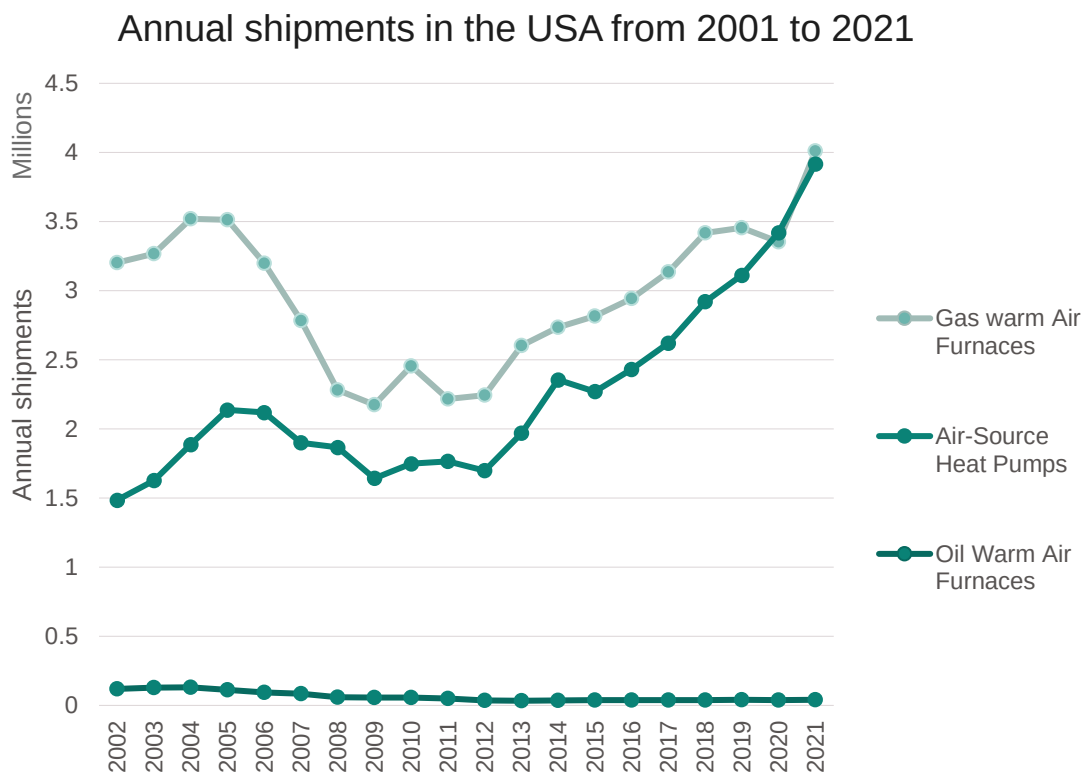
STRATEGIC NET-ZERO TECHNOLOGIES

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

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Market research – Focus: USA

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



Source: Air-Conditioning, Heating & Refrigeration Institute

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.


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

Cheryl Winokur Munk
@CHERYLMUNK

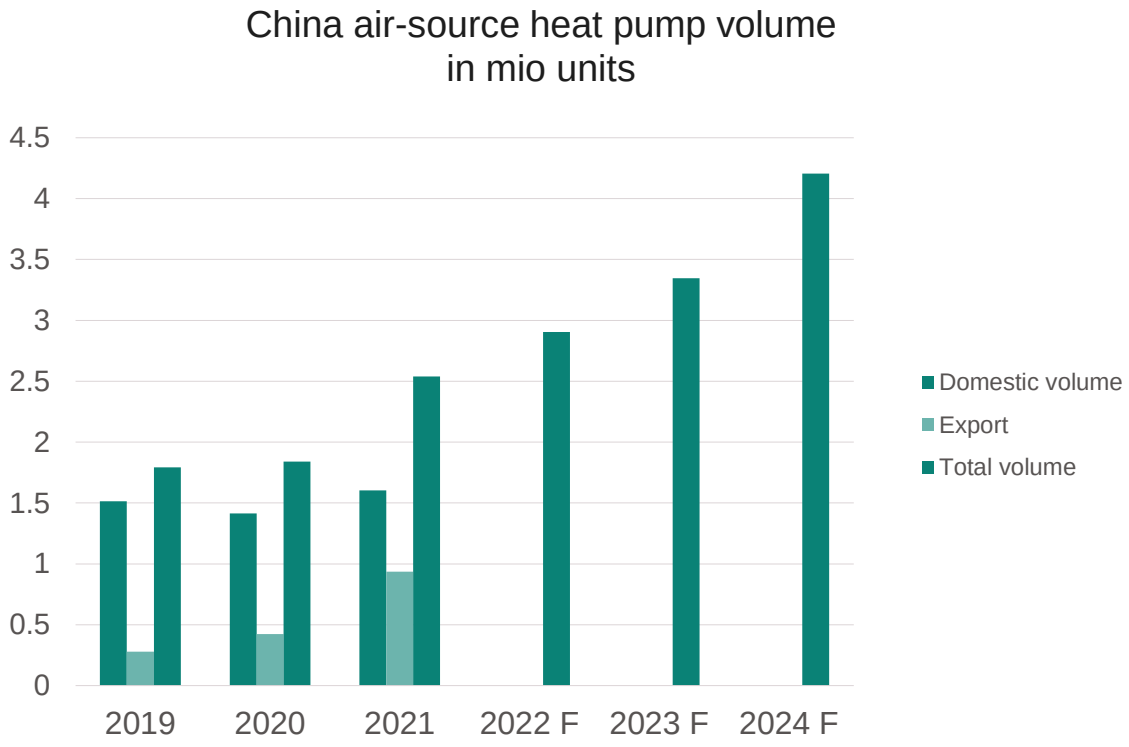
SHARE

Bloomberg

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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



Source: ChinaIOL

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

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.

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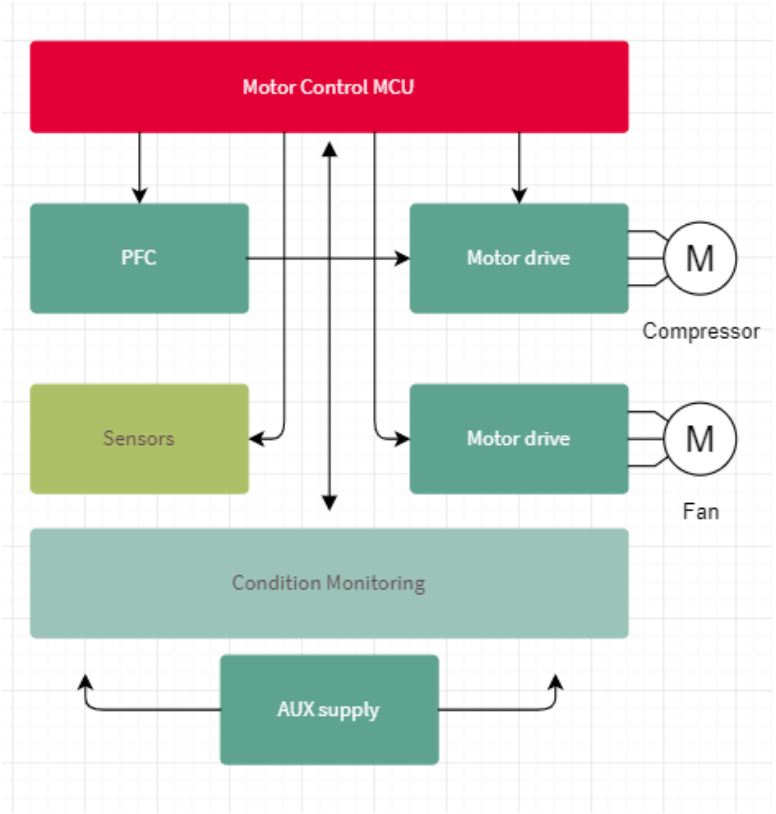
3 **Heat pump electronics** **19**

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

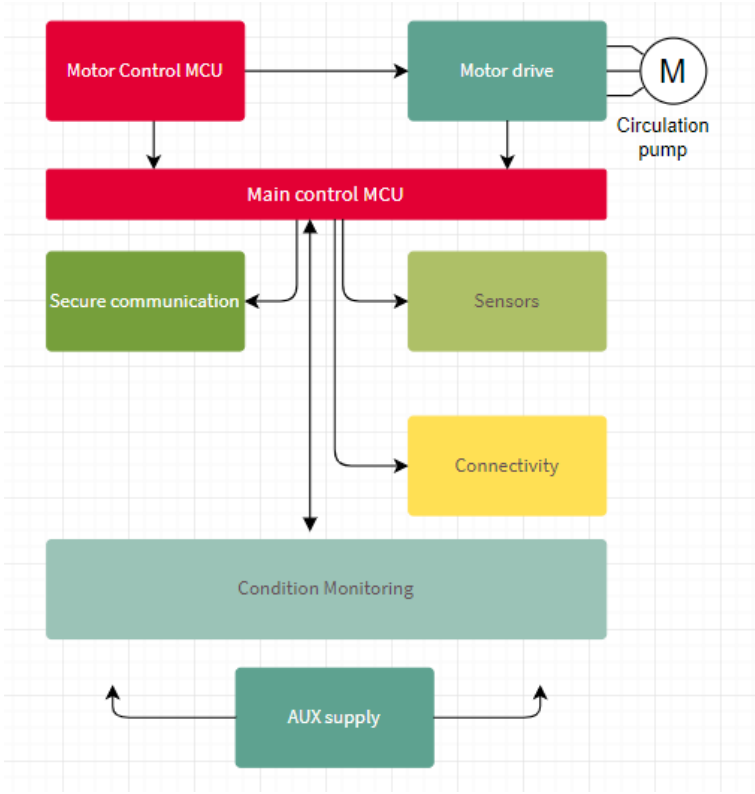
Outdoor Unit





Indoor Unit





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

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

Power level compressor	MCU	Gate driver	Power switch
low < 5 kW	PSoC™ 6/ XMC™	EiceDRIVER™	Si IGBT/ SiC MOSFET
	iMOTION™ driver (IMD110)		Si IGBT/ SiC MOSFET
	iMOTION™ controller (IMC 100 and 300)	CIPOS™ 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)		

Infineon product families



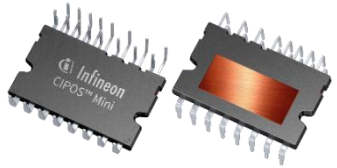
PSoC™ 4/6



iMOTION™ controller



EiceDRIVER™



IPM CIPOS™



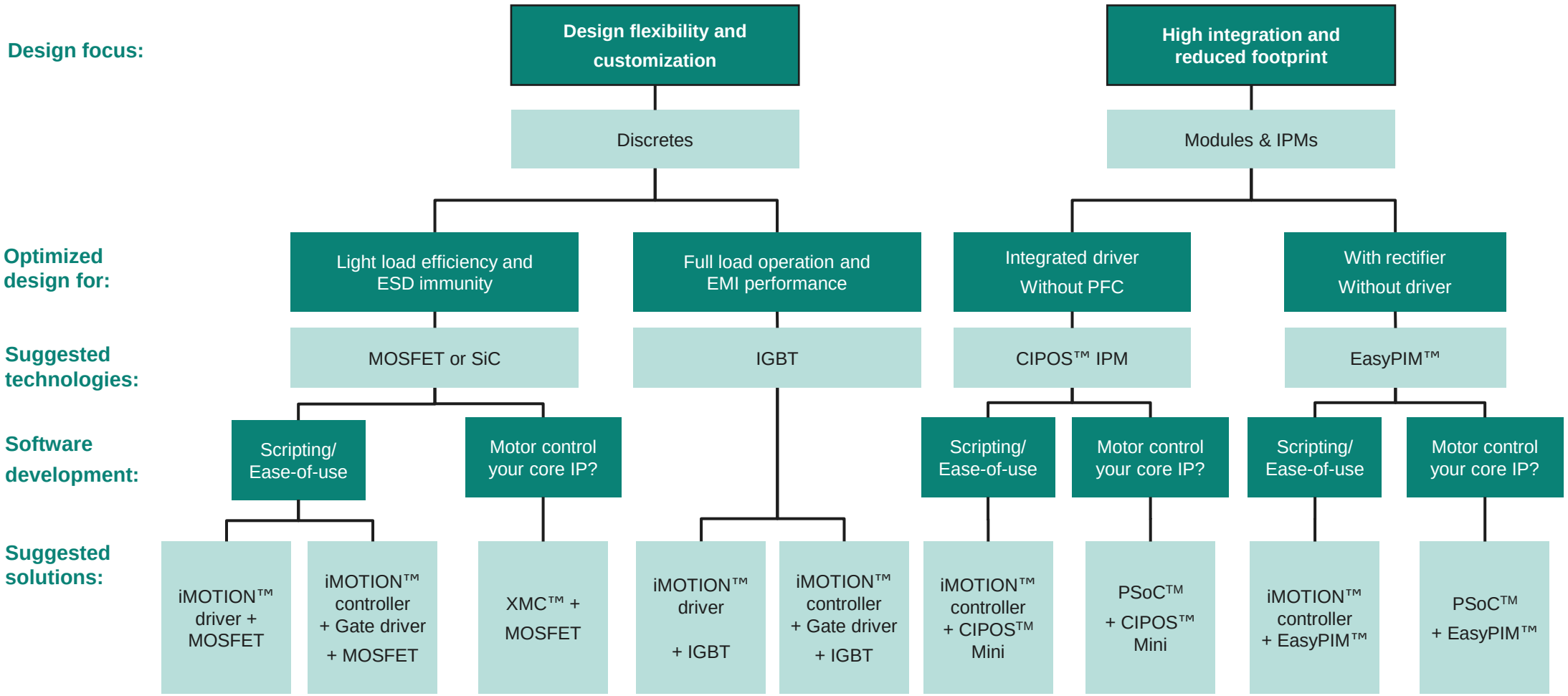
TRENCHSTOP™ IGBT



CoolSiC™ MOSFET

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Infineon offers solutions from low to high integration - It´s your choice



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Power factor correction – Topologies in heat pump systems

Most common in single-phase 3-6 kW

Highest efficiency

More and more common for 3-phase 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 rectifer needed – Meets energy regulations	– Bridge rectifer needed – Meets energy regulations	– No bridge rectifier needed – Meets energy regulations	– No bridge rectifier needed – Meets energy regulations	– No bridge rectifier needed – 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

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

Power components

PFC & Compressor PFC: 1-phase system CCM Boost converter Compressor: P_{max} < 2500 W	– iMOTION™ Controller IMC302 – CIPOS™ Mini with integrated PFC stage (IM564) – EiceDRIVER™ 1ED44175
Fan P_{max} < 200 W	– iMOTION™ Controller (IMC101T for fan only, IMC303 for dual motor) – CIPOS™ Micro
Pump P_{max} < 100 W	– iMOTION™ Controller – CIPOS™ Micro/Nano – Integrated iMOTION™ IPM

Auxiliary power supply

CoolSET™ 5th generation

Connectivity

AIROC™ Wi-Fi + Bluetooth® Combos

Security

OPTIGA™ Trust

System Control / HMI

PSoC™ 6/ CAPSENSE™

Value proposition

- Highest integration and power density
- Compact and easy to design-in
- Faster time-to-market

Sensors

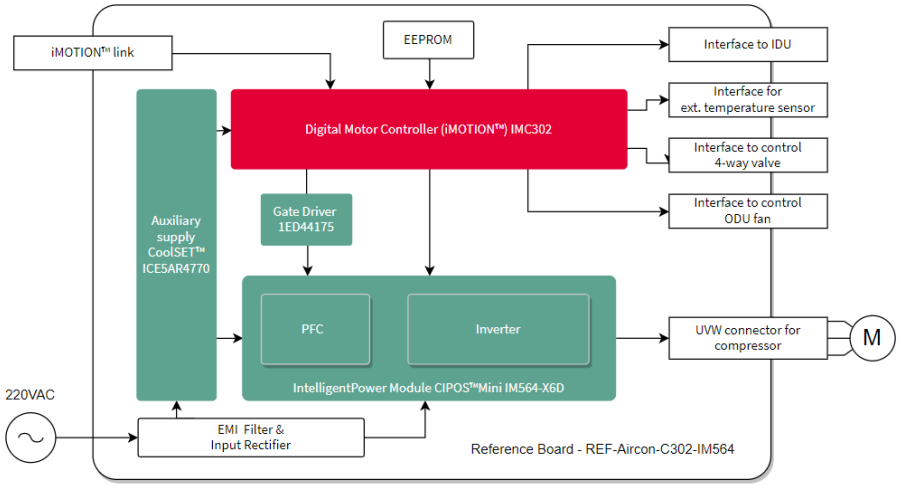
- XENSIV™ PAS CO2 sensor
- XENSIV™ MEMS microphone
- XENSIV™ Radar sensing
- XENSIV™ Current sensors
- XENSIV™ Hall sensors
- XENSIV™ Pressure sensors

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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)

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

Power components

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

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

CoolSET™ 5th generation

Connectivity

AIROC™ Wi-Fi + Bluetooth® Combos

Security

OPTIGA™ Trust

System Control / HMI

PSoC™ 6/ CAPSENSE™

Value proposition

- Highest integration and power density
- Compact and easy to design-in
- Faster time-to-market

Sensors

- XENSIV™ PAS CO2 sensor
- XENSIV™ MEMS microphone
- XENSIV™ Radar sensing
- XENSIV™ Current sensors
- XENSIV™ Hall sensors
- XENSIV™ Pressure sensors

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

Power components

PFC 3-phase active front-end	– Vienna rectifier module FS3L35R07W2H5_C40
Compressor Pmax < 7000 W	– iMOTION™ Controller – IGBT module FP35R12N2T7 – Inverter & integrated PFC (Vienna) FP35R12N2T7_B67
Fan Pmax < 1000 W	– iMOTION™ Controller – CIPOS™ Maxi (IM818)
Pump Pmax < 500 W	– iMOTION™ Controller – CIPOS™ Micro

Auxiliary power supply

CoolSET™ 5th generation

Connectivity

AIROC™ Wi-Fi + Bluetooth® Combos

Security

OPTIGA™ Trust

System Control / HMI

PSoC™ 6/ CAPSENSE™

Value proposition

- 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

Sensors

- XENSIV™ PAS CO2 sensor
- XENSIV™ MEMS microphone
- XENSIV™ Radar sensing

- XENSIV™ Current sensors
- XENSIV™ Hall sensors
- XENSIV™ Pressure sensors

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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.

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Module solutions for heat pumps – Single Phase 230V

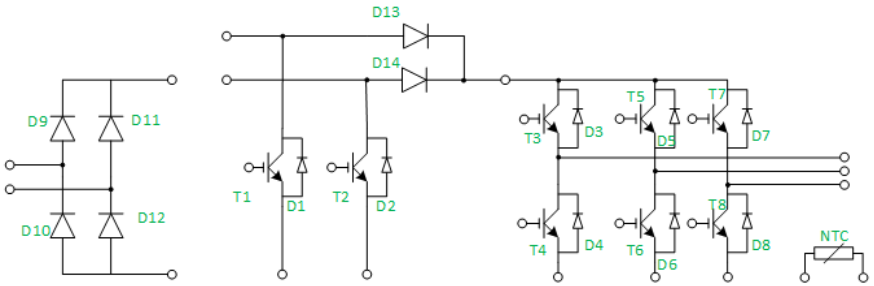
All-in-one solution (PFC and inverter) for heat pumps up to 7 kW



FB50R07W2E3_B23

High speed H5 technology for PFC

Two channel interleaved PFC



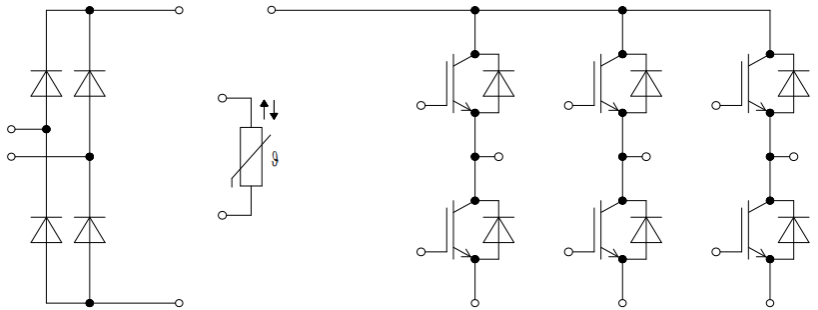
Inverter solution for heat pumps up to 5 kW



FB30R06W1E3

Very compact module (1B)

Low switching losses



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Module solutions for heat pumps – Three Phase 400V

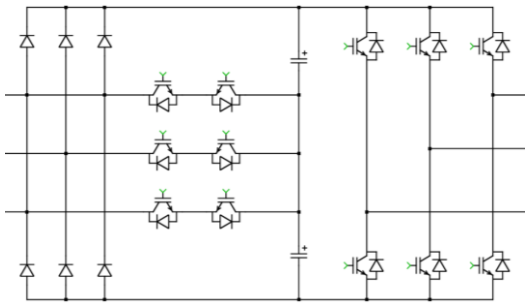
All-in-one solution (PFC and inverter) for heat pumps up to 7 kW



FP35R12N2T7_B67

High speed H5 technology for PFC / IGBT7 for inverter

Vienna PFC



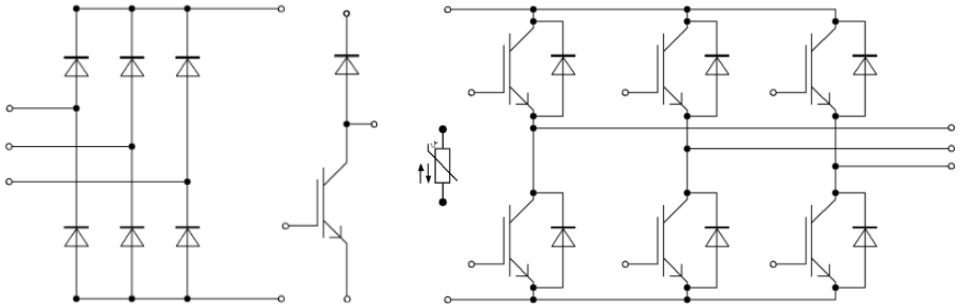
Inverter solution for heat pumps up to 5 kW



FP35R12N2T7

Baseplate module with excellent thermal performance

Low switching losses with IGBT7



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Road to Decarbonization with Infineon

Q&A

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