sdp Report

Efficiency of heat pumps: 2024 evaluation

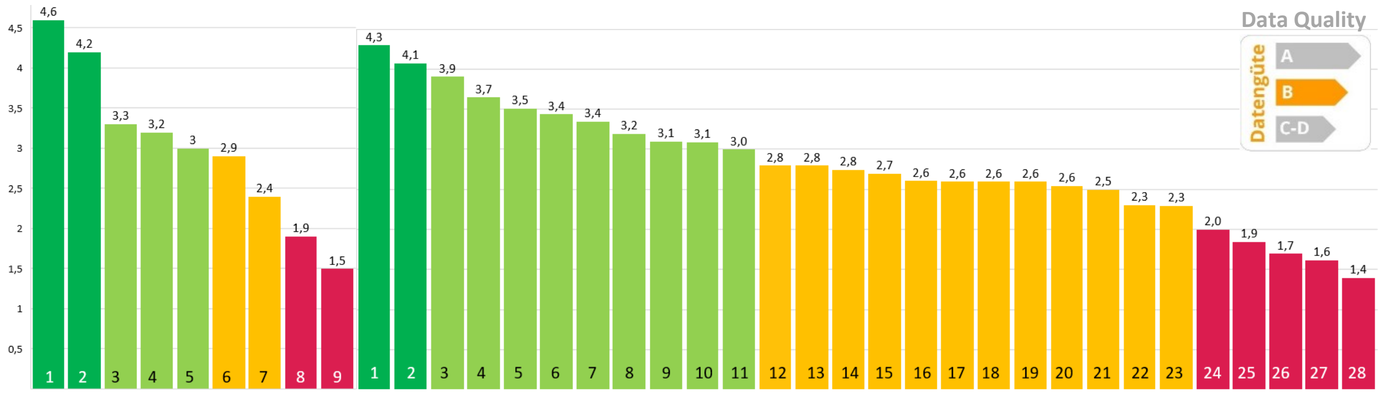
REPORT 08/2025

Stiftung Energieeffizienz
Weyerstr. 32, 50676 Köln, Germany
T: 0049 221 546 57-05

https://stiftung-energieeffizienz.org
info@stiftung-energieeffizienz.org

Data:
sustainble data platform - climate neutral buildings

Summary



***Pic. 1**: Seasonal performance factors (SPF3) for single-family homes (SFH) and multi-family homes (MFH)*

The random sample evaluation of heat pump efficiency in 2024 shows that action is needed for app. 57% of heat pumps, 16% of the systems show a significant need for action.

For private single-family homes, automatic metering has been introduced, enabling comprehensive quality assurance.

In multi-family buildings, which tend to be less efficient, an efficiency boost requires the introduction of standards to ensure the required minimum efficiency and the professional integration of hot water preparation and heating elements.

Since 2022, the St. Gallen Energy Agency, Fraunhofer ISE, and the Energy Efficiency Foundation have been providing private households with free monitoring for efficient heat pumps. Twenty test households in Austria and Germany tested the automatic recording of meter readings using a certified metering set.

This short report presents the results for 2024 without selection and compares them with those of typical multi-family homes (excluding relevant SDG7 indicators for costs and CO_2). The categorical analyses and case studies from operational practice refer to the application case of heating without cooling.

In multi-family buildings, which tend to be less efficient, an efficiency boost requires the introduction of standards to ensure minimum efficiency and the professional integration of hot water preparation and heating elements.

The aim of the report is to provide feedback to WP-Cockpit and MFH participants as well as to the stakeholders of the sustainable data platform (sdp) in the WP-Cockpit and climate-neutral-buildings (CNB) modules.

The random sample evaluation in the 2024 operating year shows performance figures (SPF3) between 1.4 [-] and 4.6 [-] with an average of 3 [-] for the 9 single-family home systems and 2.8 [-] for the 28 multi-family home systems. The 7 air source heat pumps in single-family homes have an average seasonal performance factor (SPF) of 3 [-], while the 15 air source heat pumps in multi-family homes have an average SPF of 2.4.

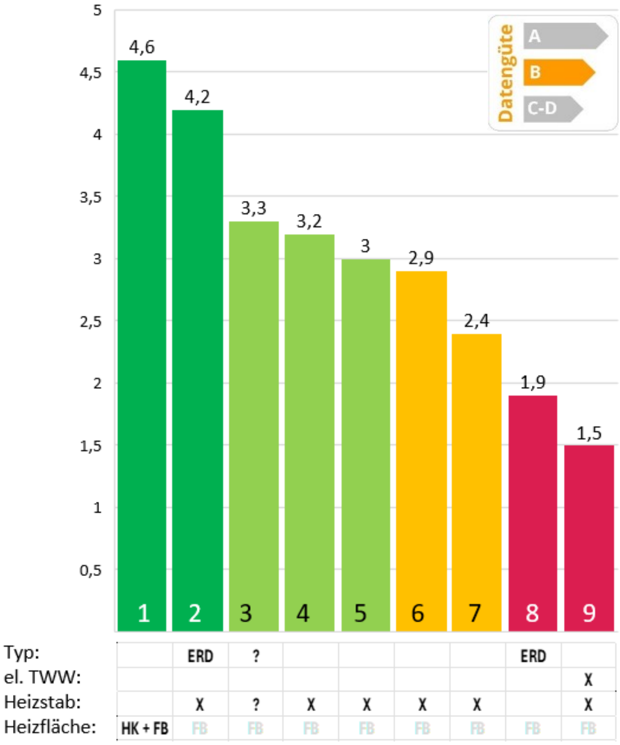
In 57% of the heat pumps, the SPF was below the recommended guarantee value of 3.0 [-]. 16% of the heat pumps had performance factors below the low-value benchmark (red) of 2 [-], while in 11% the SPF was above the high-value benchmark of 4 [-] (green).

The causes of the high efficiency differences are known, particularly from the group of multi-family houses. It is suspected that concepts with low system temperatures for single-family houses were in some cases improperly applied to multi-family houses without the necessary modifications (compensation via heating elements or electric boilers).

Random samples of measured coefficients of performance and those determined from manufacturer controllers were compared. The deviations ranged between 12% and 140%. The causes were manufacturer balance sheets that only referred to the compressor and the failure to take heating elements into account.

Single-family heat pumps in the WP Cockpit Start group

Of the approximately 15 participants in the starting group, operating results are available for 12 plants, of which the results for 9 plants are complete and plausible for the operating year 2024.



***Pic. 2**: Systems in the WP-Cockpit field test EFH (A-D). The heat source is air, with the exception of systems 2 and 8, which are supplied with geothermal energy.*

The nine single-family homes (private buildings as single-family or two-family houses) are heated with underfloor heating, with the exception of system 1, which has a combination of underfloor heating and radiators. Drinking water is heated separately by electricity only for heat pump 9 (WP9). The other heat pumps supply heating and hot water.

Optimizations were reported for heat pumps WP4 and WP7. For WP4, standby consumption was reduced (heating switched off intermittently). (SPF improved from 2.9 [-] to 3.2 [-] from 2023 to 2025. For WP7, the low SPF detected led to checks. "Unfortunately, the customer service technician was unable to find an explanation for this," so the owners carried out their own analysis (SPF from 2023 to 2025 unchanged at approx. 2.4 [-]).

Optimizations are planned for WP 8, but have not yet been implemented due to time constraints.

For the heat pumps, the SPF values readable on the devices were queried, but some of these could not be read and were reported for two systems. For WP1, the SPF value read was 5.15 [-] in relation to the measured coefficient of performance of 4.6 [-]. For WP6, a SPF of 3.4 [-] was reported compared to 2.9 [-].

Automatic monitoring of operating figures with weekly or monthly reports and information on deviations is running largely trouble-free in the test group. Problems during the installation phase arose in particular with the complicated wiring of the initial wired electricity meter, which was replaced by an electricity meter with a wireless M-Bus module.

Insights for SDP participants

Several reports mentioned an "aha moment" when efficiency was made transparent for the first time.

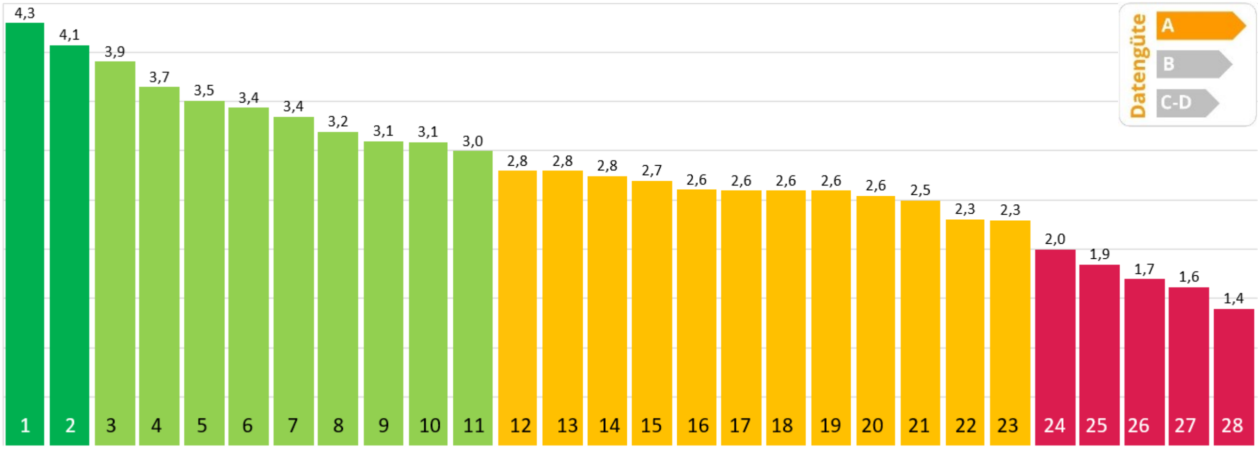
Once inefficient operation had been identified, it was hardly possible to make improvements retrospectively. Quality assurance for new systems must be implemented at an early stage, and fault detection must be automated for existing systems.

The cost of the metering sets was approximately EUR 1,000 each before subsidies (wireless M-Bus electricity meters). The sets were used to reliably record data quality B measurements (without on-site verification) (data quality A possible with random sampling).

As in Switzerland, the WP Cockpit approach is not automatically successful in Germany and Austria. Its dissemination is recommended in funding programs. Here, the running costs for support with automatic measurement recording are estimated at approximately EUR 10-25 per system per year for a quantity of 1,000.

Technically, master data recording for machine learning and statistical evaluations needs to be optimized, and cold recording needs to be integrated.

Comparison group: multi-family housing systems



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Typ:	ERD	WAS	WAS	ERD	WAS	EIS	EIS		EIS	WAS										ERD		ERD	EIS*					
Elek. TWW:	X			X		X	X		X		X	X		X			X							X	X			
Heizstab:							X	(i)				(X)					(X)				(X)		X		X	X		X
Heizfläche:	FB	FB	FB	HK	FB	FB	FB	FB	FB	FB	FB	FB	HK	FB	HK	FB	FB	HK	HK	FB	HK	FB	FB	HK	HK	HK	FB	HK
GarantieV.:		X	X	X	X					X																		
Hybrid:													GAS		GAS	GAS		GAS	GAS		GAS						GAS	

***Pic.3**: Results for MFH systems with information on the type of heat pump (ERD-ground source, WAS-water, EIS-ice storage), heating rods or electric boilers, heating surfaces (HK-radiators), warranty contracts, and hybrid heating (GAS-gas boilers).*

Residential systems with a seasonal performance factor (SPF) above 3.2 [-] obtain their heat from the ground, ice storage tanks, and wells. “Good” air source heat pumps show expected seasonal performance factors between 2.7 [-] and 3.2 [-]. Air source heat pumps with radiators achieve maximum seasonal performance factors of 2.6-2.8 [-] (cf. ground source WP4 with radiators and seasonal performance factor of 3.7 [-]).

Pic. 4: The results for the MFH systems come from monitoring on the sdp-CNB portal (shown in the image) and the energy-check MySQL database.

SPFs below 2 [-] occur in particular in air source heat pumps with radiators and electric heating elements or electric boilers.

Failure to meet targets results in particular from planning errors, untested system technology (transfer from single-family home systems not permitted), incorrect settings, and the accumulation of “minor” causes. Errors are particularly likely to occur when integrating hot water preparation and heating elements or boilers.

It is assumed that, for efficient system operation, quality assurance is even more important than low sink temperatures (e.g., radiators with surface reserve) for air source heat pumps with JAZ > 3. Data on design, storage and cycle behavior, radiator reserve, and insulation (pipeline losses) should be included in the analysis.

Insights for participants

Optimizations during the warranty period are carried out in the MFH group on a contract-dependent basis, but involve a great deal of effort.

The greatest potential for optimization lies in the long-overdue introduction of quality assurance standards (contractually agreed annual average energy consumption) and the hydraulic and control integration of hot water preparation and heating elements in MFH systems.

Further Information

It has been proven that simple methods can be used to create a broad database for evaluating the energy transition and as a basis for a successful heat pump rollout. Data quality can be improved by taking random samples.

The evaluation shows that single-family home systems in particular are affected by a lack of feedback mechanisms. Without the early integration of quality specifications, private investors often have no chance of optimizing "poor systems" retrospectively.

Since subsidy programs do not include quality assurance with proof of efficiency and CO_2 emissions during operation, it must be examined whether, for example, the civil society approach of "evidence-based construction methodology" can be transferred to single-family homes.

For statistical evaluations and open data exchange, the recording of essential input and output data must be further simplified and coordinated (including h-value from EAV, distribution losses, storage stratification, radiator reserve, PV self-consumption, cooling, and cycle times).

For better data availability

The anonymized publication of data from the sustainable data platform modules climate-neutral-buildings and WP-Cockpit is in accordance with the code of the sustainable data platform and statutes of the Stiftung Energieeffizienz.

We welcome donations and support for our volunteer work.

Pic. 5: Common combination for single-family and multi-family homes, heat pump, and PV system

Support

https://sustainable-data-platform.org/support/

For transparency in the heat transition!

climate-neutral buildings: Building module of the sustainable data platform

sdp-CNB supports the efficient operation and limitation of energy costs for buildings, housing stocks, and neighborhoods. Based on proven key indicators for efficiency and energy consumption, it supports the most economical achievement of climate-friendly stocks. For resource reasons, the WP Cockpit module was integrated in 2024.

https://sustainable-data-platform.org/climate-neutral-buildings/