Heat Pump Seasonal Performance by the Bin Method

Seasonal heat, electricity and SCOP of a heat pump from four outdoor temperature bins with hours and COP and a load line from the design point.

Method: Bin method (ASHRAE Handbook—Fundamentals (2017), ch. 19, energy estimating)

Input parameters

Unit system: SI

Parameter	Value	Unit
Design heat load	10.000	kW
Design outdoor temperature	-5.0000	°C
Balance (no-load) temperature	15.000	°C
Bin 1 temperature	-2.0000	°C
Bin 1 hours	500.00	h
Bin 1 COP	2.6000	
Bin 2 temperature	3.0000	°C
Bin 2 hours	1,200.0	h
Bin 2 COP	3.1000	
Bin 3 temperature	8.0000	°C
Bin 3 hours	1,500.0	h
Bin 3 COP	3.7000	
Bin 4 temperature	12.000	°C
Bin 4 hours	1,000.0	h
Bin 4 COP	4.3000	

Calculated results

Parameter	Value	Unit
Seasonal heat delivered	18,200	kWh
Seasonal electricity	5,725.0	kWh
Seasonal COP	3.1791	

Notes for this case

- Linear load line from zero at the balance temperature to the design load. The COP for each bin should include defrost and cycling losses; backup heater use below the bivalent point is not modelled (enter its COP as 1 for those bins).

Formula and method

$$Q_i = Q_d \frac{t_b - t_i}{t_b - t_d}, \quad SCOP = \frac{\sum Q_i h_i}{\sum Q_i h_i / COP_i}$$

Variables

Q_d	Design heat load	W
t_d	Design outdoor temperature	K
t_b	Balance (no-load) temperature	K
t_1	Bin 1 temperature	K
h_1	Bin 1 hours	s
COP_1	Bin 1 COP	-

t_2	Bin 2 temperature	K
h_2	Bin 2 hours	s
COP_2	Bin 2 COP	-
t_3	Bin 3 temperature	K
h_3	Bin 3 hours	s
COP_3	Bin 3 COP	-
t_4	Bin 4 temperature	K
h_4	Bin 4 hours	s
COP_4	Bin 4 COP	-
E_h	Seasonal heat delivered	J
E_e	Seasonal electricity	J
$SCOP$	Seasonal COP	-

Method and standards

Bin method.

Assumptions and limits

- Linear load line; four bins.
- The heat pump is assumed to meet the whole load in every bin; its capacity limit is not modelled. Below the bivalent point, where a backup heater carries part of the load, enter a lower blended COP (1 for an all-electric backup bin).

References

• Bin method (ASHRAE Handbook—Fundamentals (2017), ch. 19, energy estimating)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/hvac/refrigeration/heat-pump-seasonal-bins

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.