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Heat Pump Field Trials and Implications for Design

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The Solar Design Company

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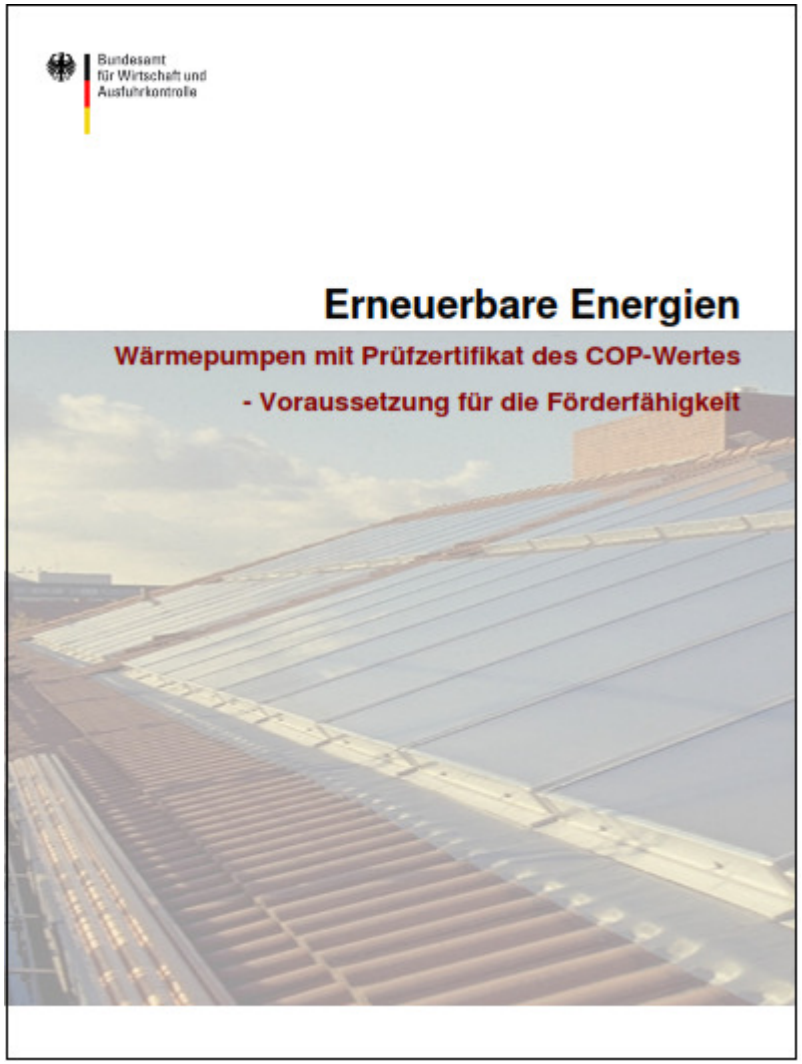
German subsidies



- **Marktanreizprogramm (Market Incentive Programme)**

GSHP System	Subsidy
Under 10kW	2400€
10kW-20kW	2400€ + 120€ per kW above 10kW
Additional solar thermal support	+500€

German regulations

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HERSTELLER	TYP	COP [bei B0 / W35]	NENNWÄRME-LEISTUNG [bei B0 / W35]	PRÜFNORM	TEMPERATUR-DIFFERENZ [bei B0 / W35]
AEG Markenvertrieb EHT Haustechnik	WPF 10	**4,50** *(4,3)*	**9,90 kW**	EN 255 *(EN 14511)*	9,9 K *(5,0 K)*
Alpha-InnoTec GmbH	KHZ-SW 60(K)/300	**4,40**	**5,70 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	KHZ-SW 70(K)/300	**4,40**	**6,90 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	KHZ-SW 60(K)/400	**4,40**	**5,70 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	KHZ-SW 70(K)/400	**4,40**	**6,90 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	KHZ-SW 80(K)/400	**4,37**	**9,00 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	KHZ-SW 100(K)/400	**4,60**	**10,20 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 60 (H/K)	**4,40**	**5,70 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 70H (H/K)	**4,40**	**6,90 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 80H (H/K)	**4,37**	**9,00 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 100 (H/K)	**4,60**	**10,20 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 120 (H/K)	**4,50**	**11,70 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 140 (H/K)	**4,41**	**14,21 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 170 (H/K)	**4,60**	**16,70 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWC 230 (H/K)	**4,30**	**22,10 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWP 371	**4,79**	**37,18 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWP 451	**4,79**	**45,03 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWP 581	**4,77**	**57,56 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	SWP 691	**4,65**	**68,48 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	WZS 61 (H/K)	**4,60**	**6,00 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	WZS 81 (H/K)	**4,47**	**7,49 kW**	EN 14511	5,0 K
Alpha-InnoTec GmbH	WZS 101 (H/K)	**4,70**	**9,60 kW**	EN 14511	5,0 K
Arwego e.K.	WP11	**4,50**	**11,20 kW**	EN 14511	5,0 K

Comparison of heat pump trials

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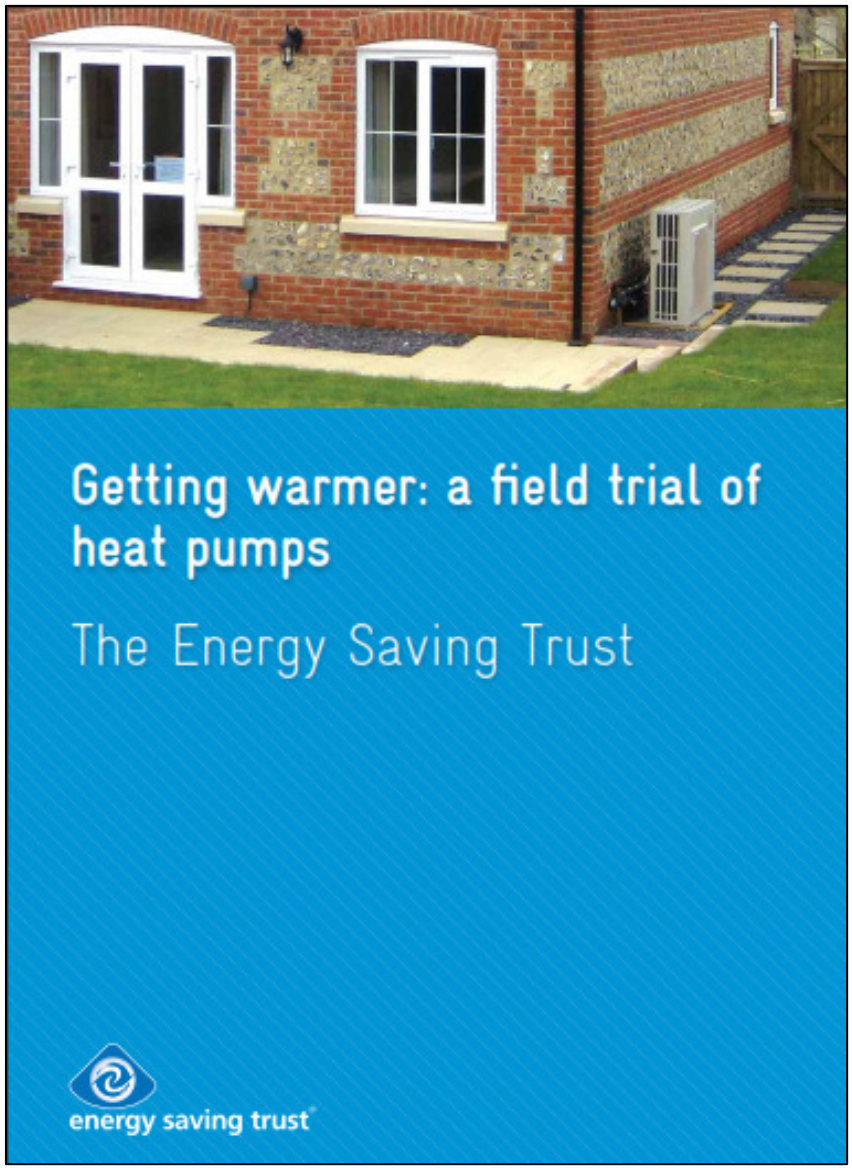
Fraunhofer ISE

Heat Pump Efficiency
Analysis and Evaluation of Heat Pump Efficiency in Real-life Conditions



Comparison of heat pump trials

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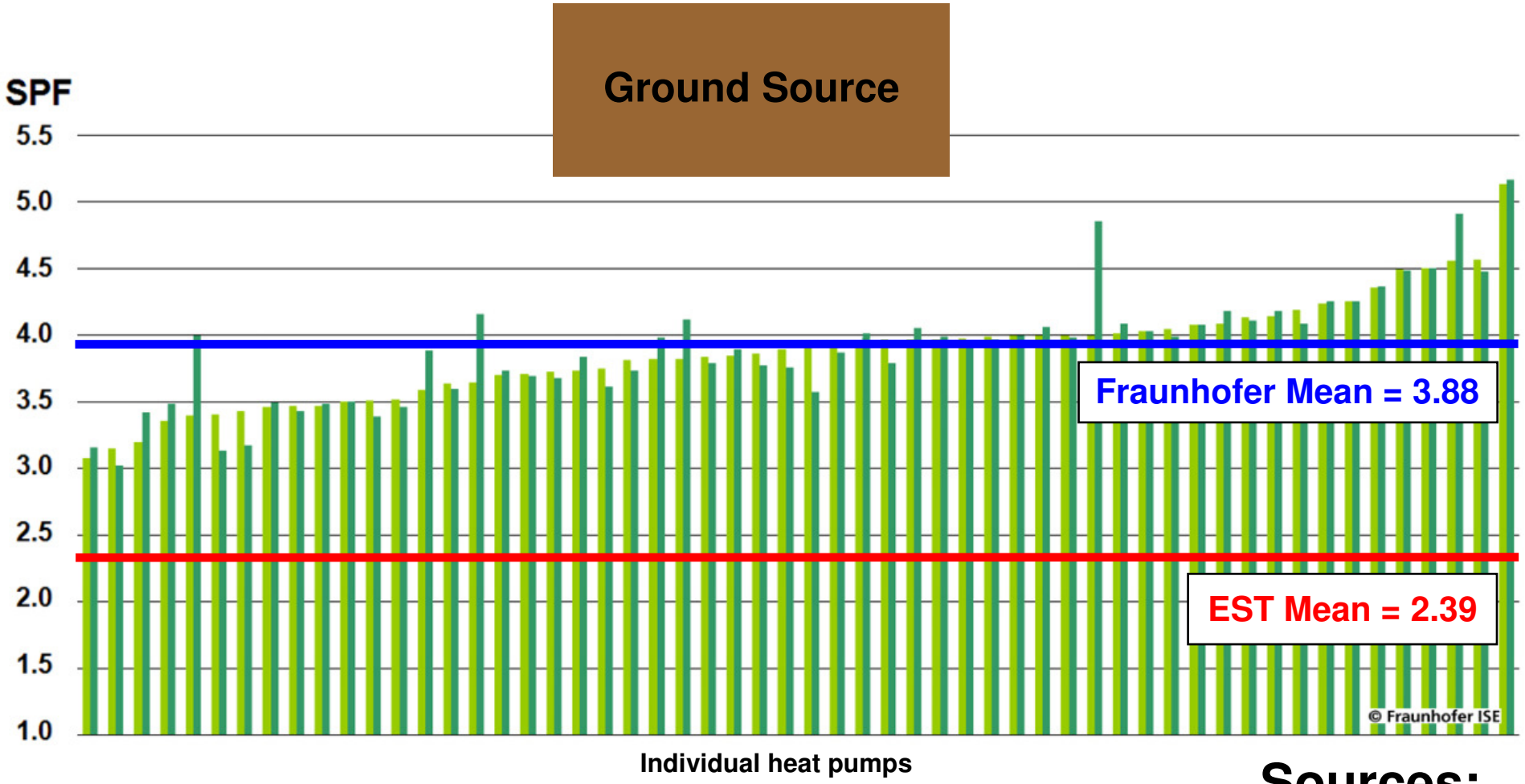

Sources:

Fraunhofer (2011)

EST (2012)

Comparison of heat pump trials

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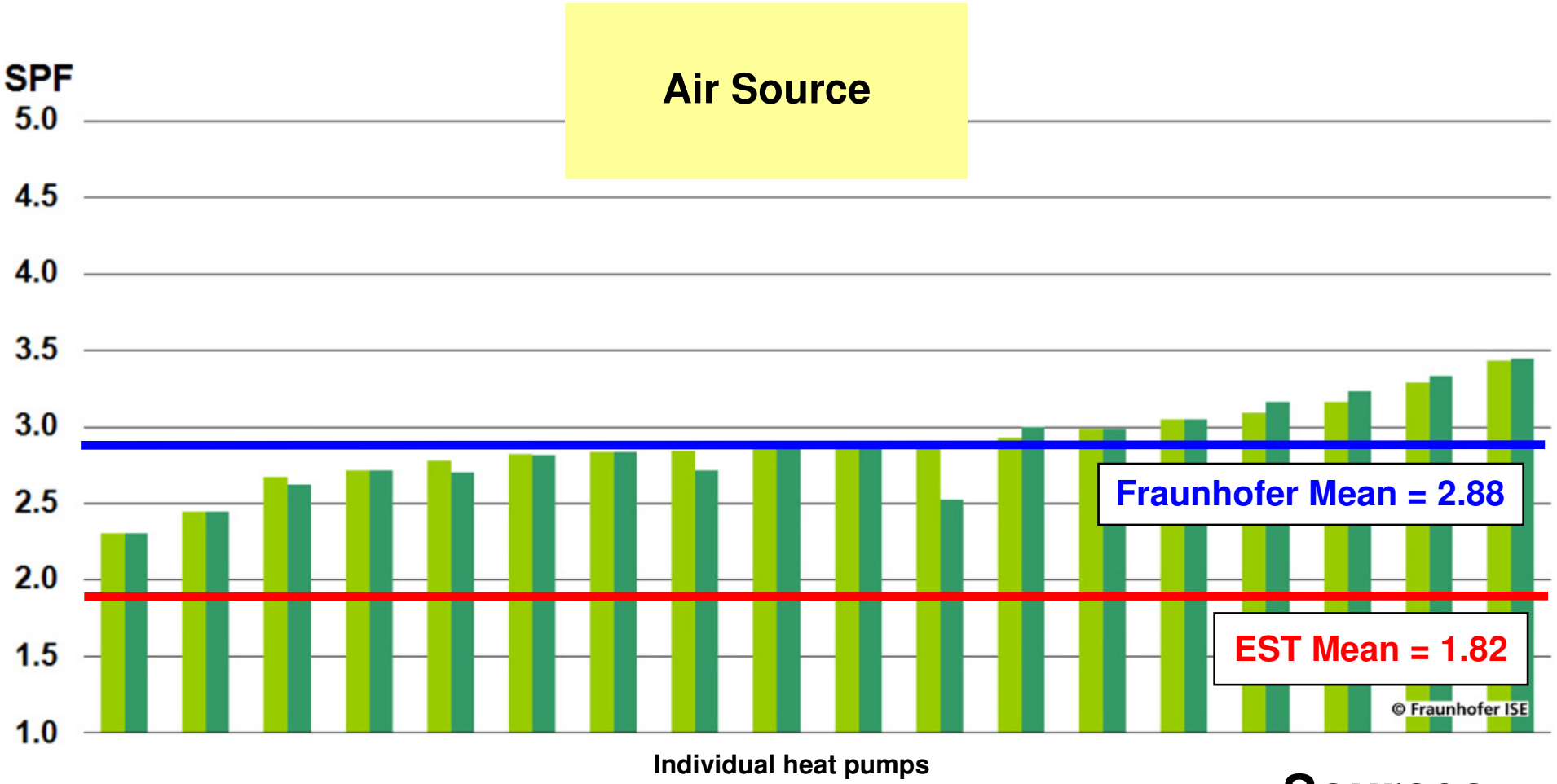

Sources:

Fraunhofer (2011)

EST (2012)

Fair comparison?

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Fraunhofer sample:

"[…] mainly <u>new</u> energy efficient residential buildings"

Mean heating demand of 72 kWh/m²/a.

Fair comparison?

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EST Phase One sample:

"[…] representative sample of air and ground source heat pump installations in a variety of property types, focussing primarily on retrofit installations"

Heat emitter comparison

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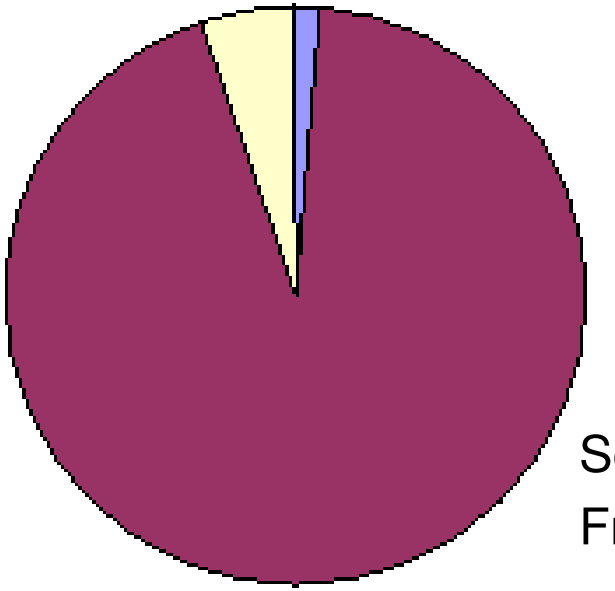
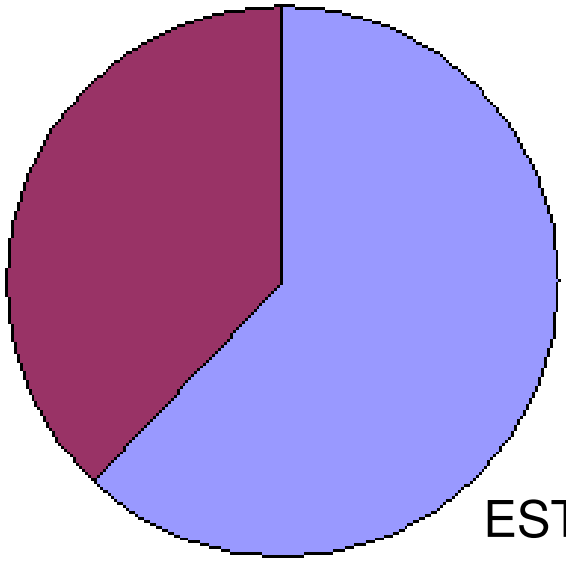
Fraunhofer sample



Source:
Fraunhofer (2011)

- Radiator heating
- Under-floor heating
- Combined systems

EST Phase One sample



Source:
EST (2012)

- Largely radiator heating
- Largely under-floor heating

System measurement boundaries: Fraunhofer

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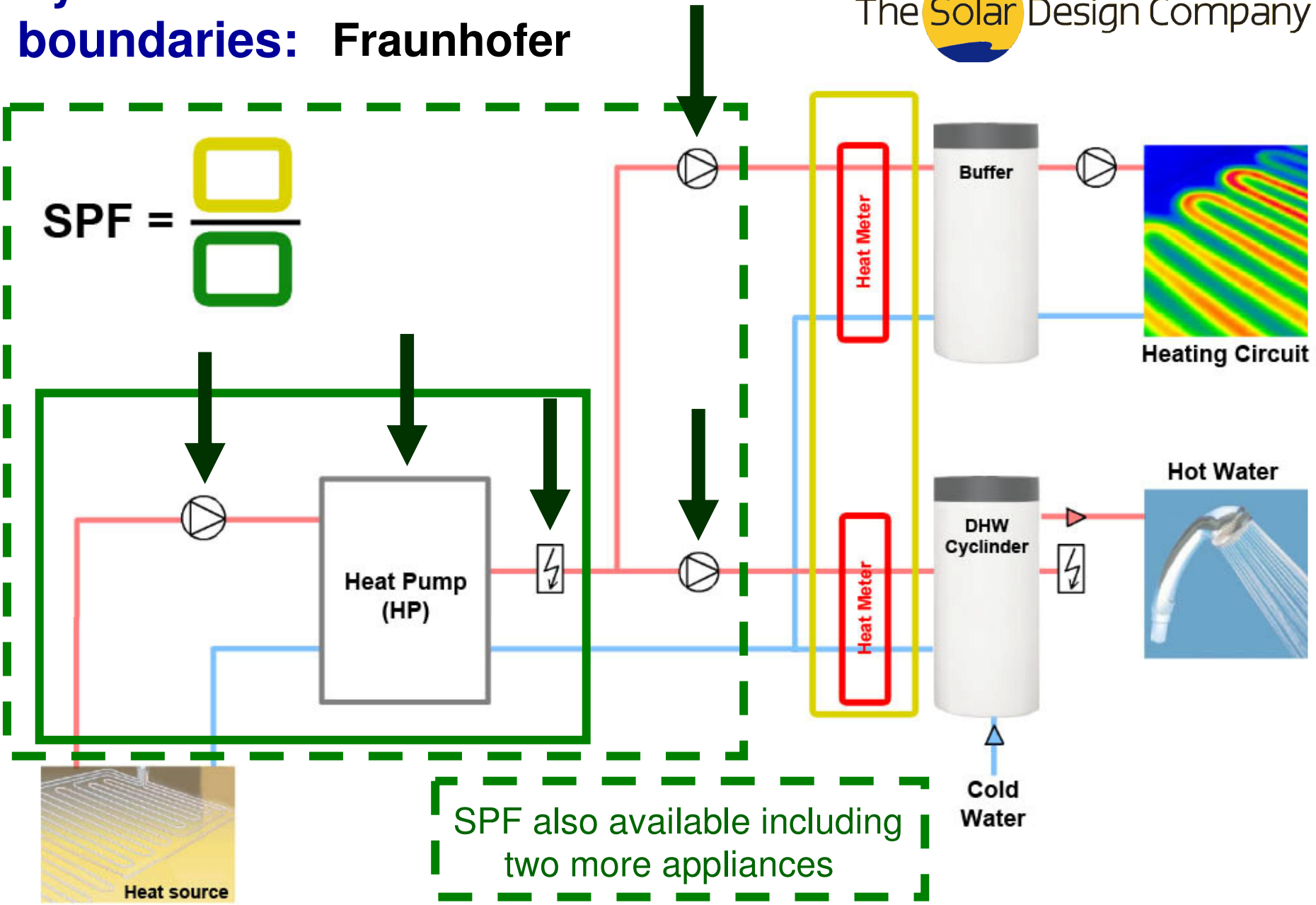

System measurement boundaries: EST

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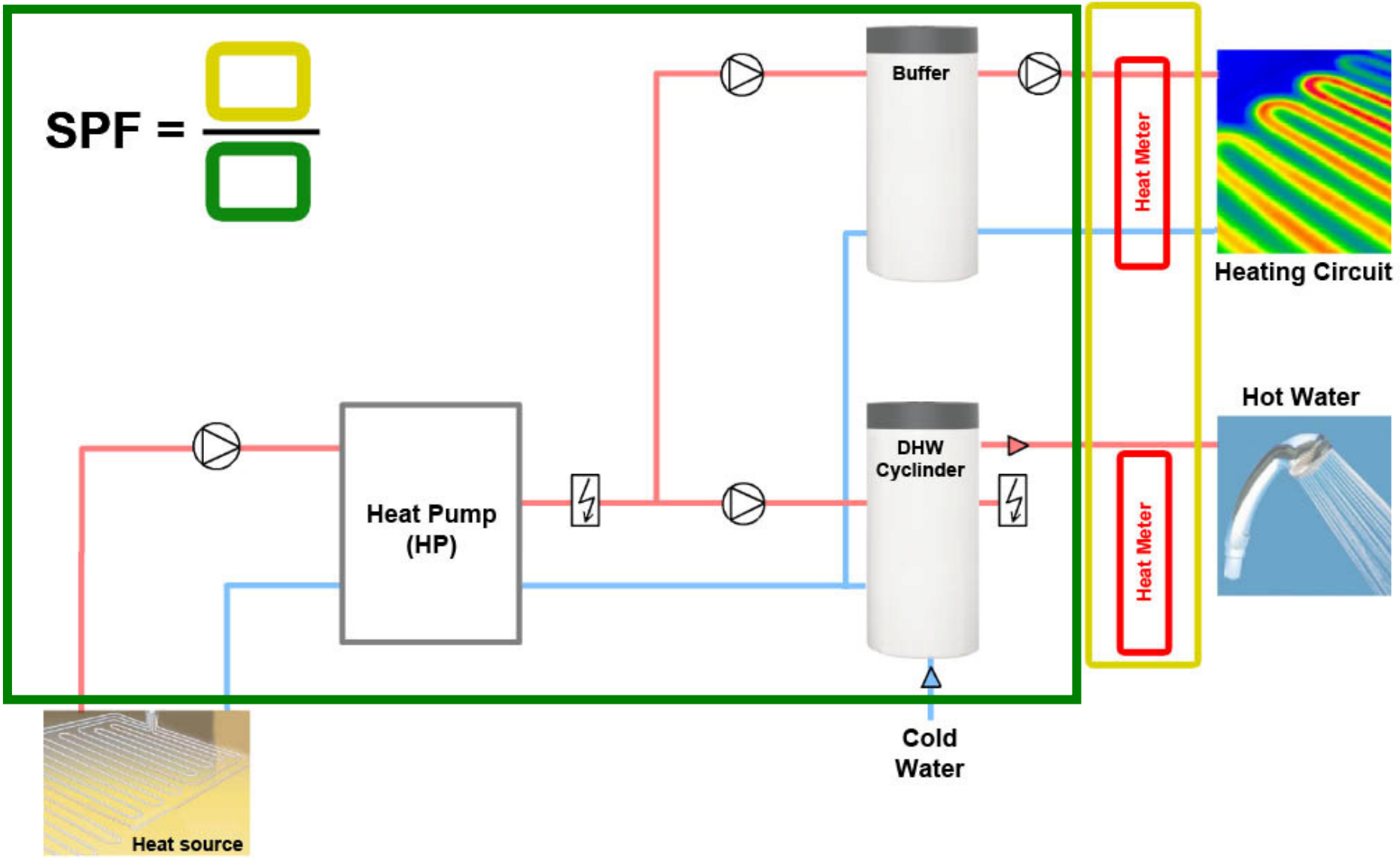

Comparison of heat pump trials

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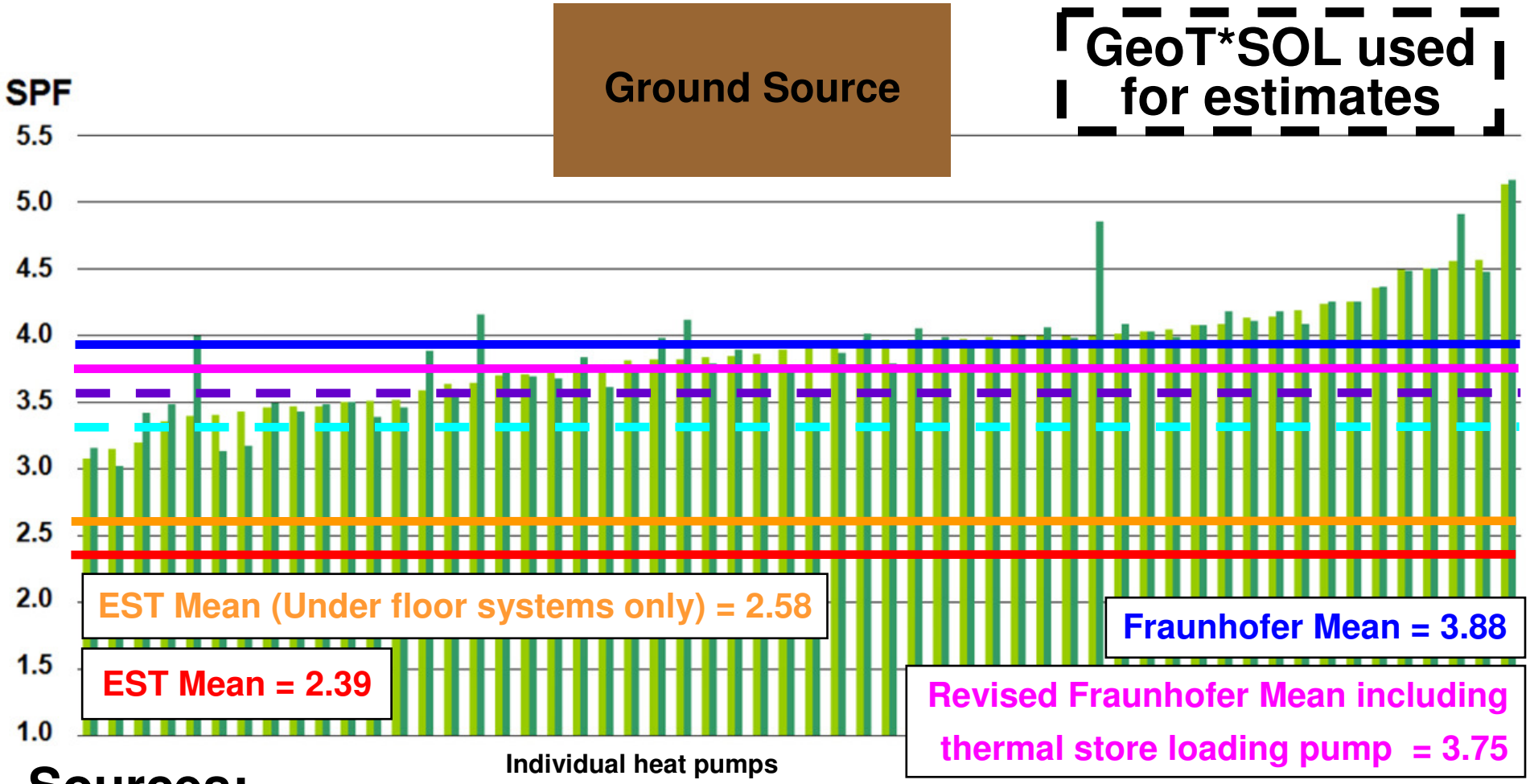

Sources:

Fraunhofer (2011)

EST (2012)

Reports' recommendations

Fraunhofer	EST phase one
Modest design tweaks: • Ground collector primary pump sizing • Comments on use of buffer tanks • Poorly performing combined thermal storage	**Fundamental issues:** • Heat pump under-sizing • Ground collector under-sizing

Key outcomes

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Fraunhofer – software (GeoT*SOL)	EST – Manual calculation
Simulation design software (Hourly)	MIS 3005 manual calculation (revised)
Hourly climate data files	Annual totals / Regional climate
Iterative error reporting	No feedback to incorrect calculations
System temperature predictions	Not explicitly provided
Manufacturers' 7 test points to EN 14511 for individual heat pumps	Utilises single COP figure from Heat Emitter guide

Modelling performance

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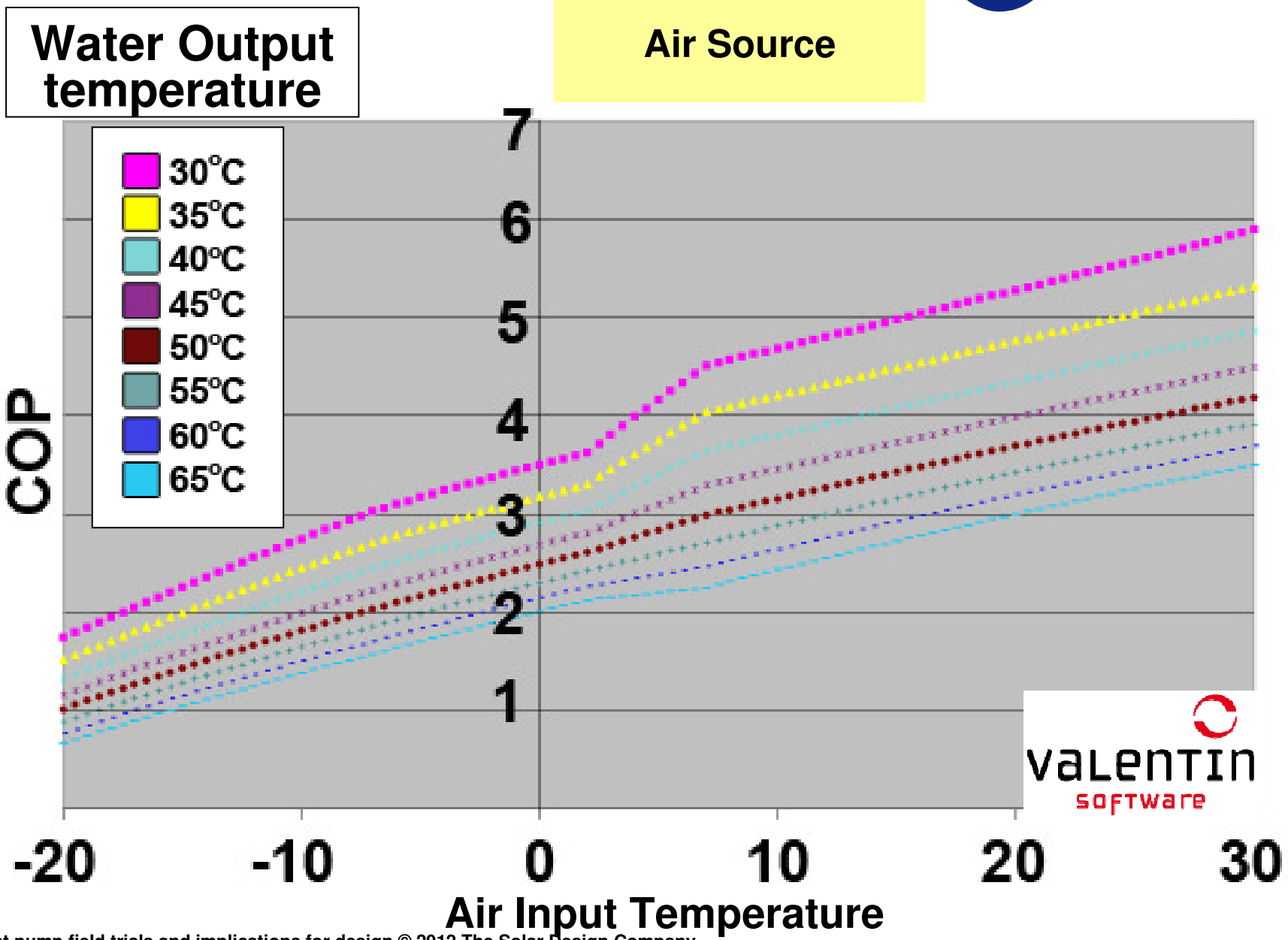

Software verification

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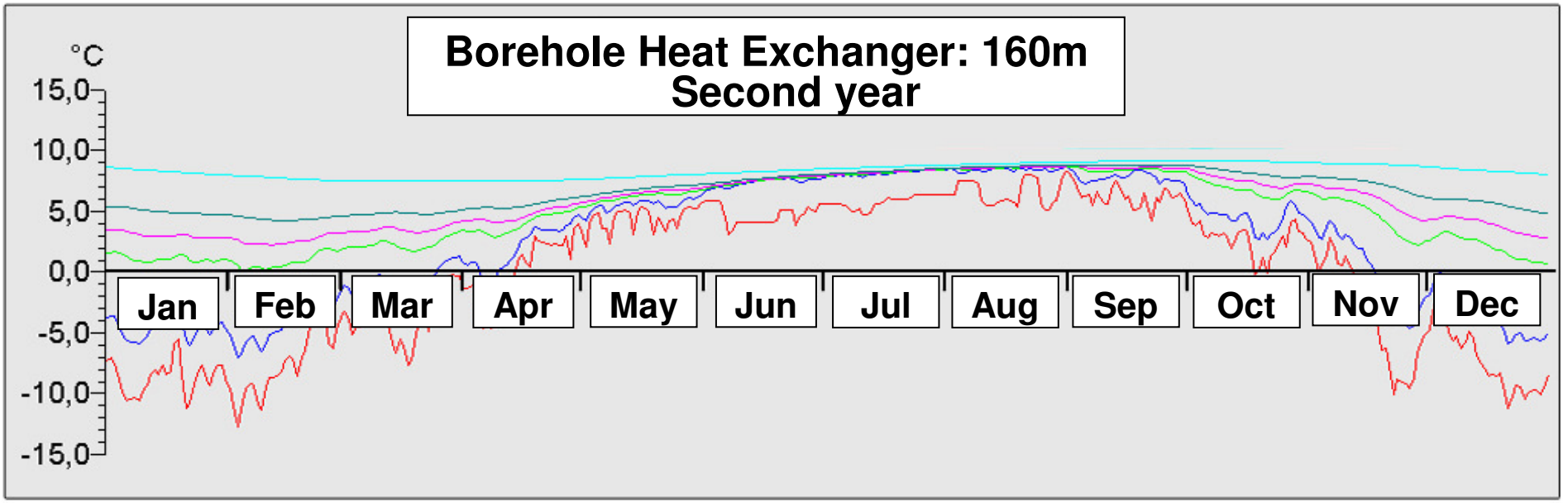

valentin
software

Software verification

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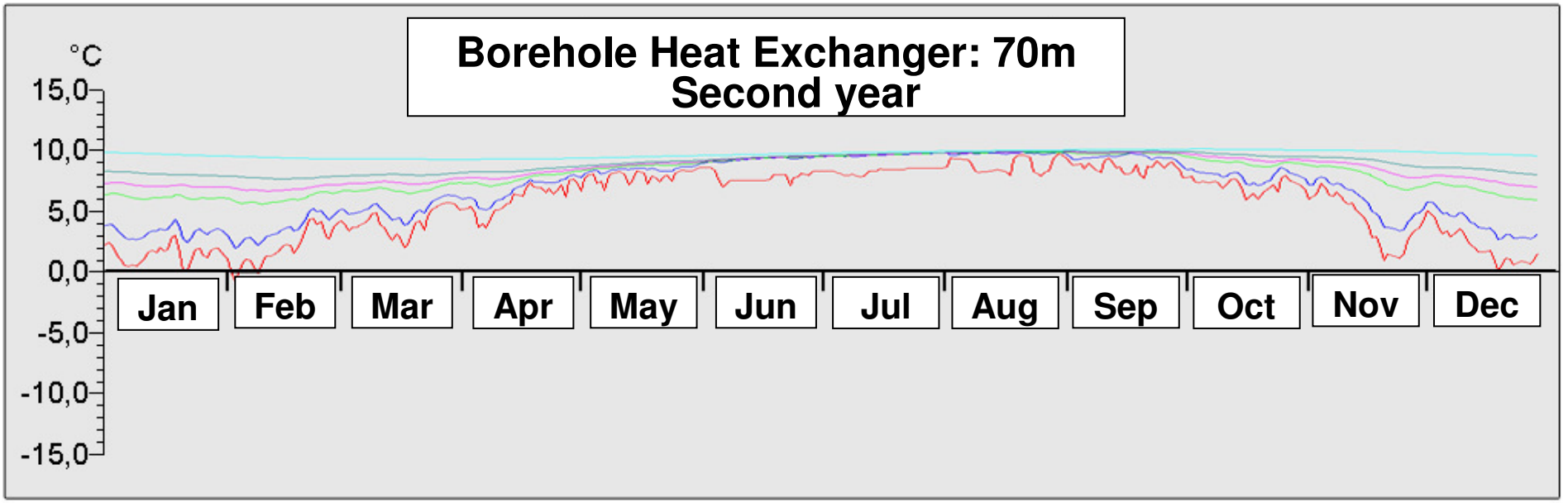

valentin software

Implications for design: Ground collector sizing

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Software simulation tools mitigate:

- Under sizing Min 0˚C thermal transfer fluid, extracting more heat than can be replenished. (MIS 4.2.13)
- Over sizing (increased cost of installation)
- Manual calculation errors
- Manufacturer data entry errors

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