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solar thermal homesystem - modelling and cost

Renewable Energy Heat

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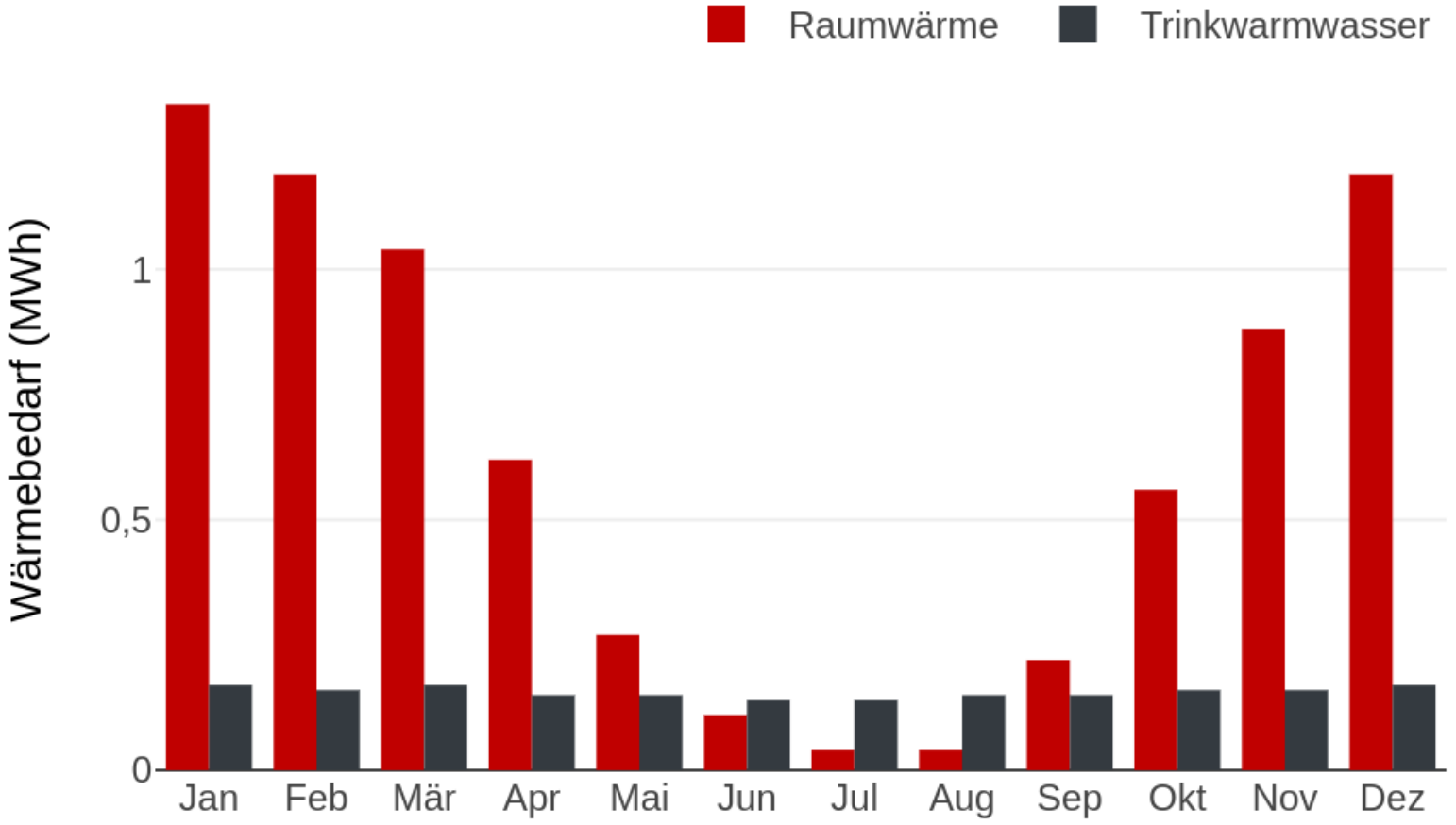
- Motivation
- Demand & supply
- System configuration
- Methods
- Results & Conclusion
- Discussion

Motivation

- Performance of solar thermal systems?
- Variance of performance?
- Seasonal variations?
- Cost savings?
- Best configuration?

Demand & supply

Source: https://app.npro.energy/en



Parameters:

- KfW70 energy standard
- 120 m ²
- 5 people
- 300 m³/a
- Energy consumption: 8.5 – 11 MWh / a
- min. T = 15°C

Fig. 1 Energy demand for SH & DHW

Demand & supply

Source: sahra2, 2020 - https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html

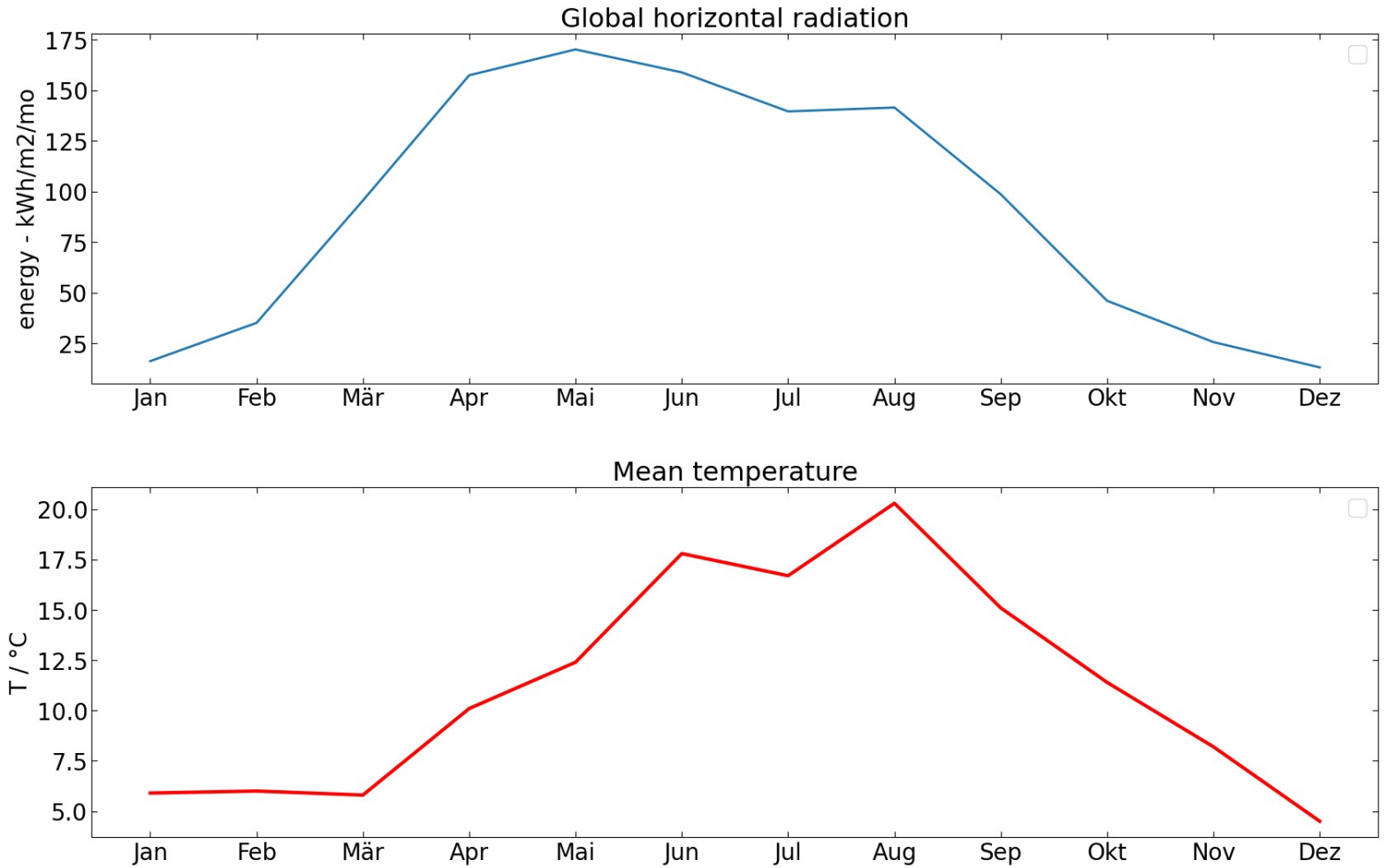


Fig. 2 Monthly avergae irradiance and temperature for Oldenburg

System configuration

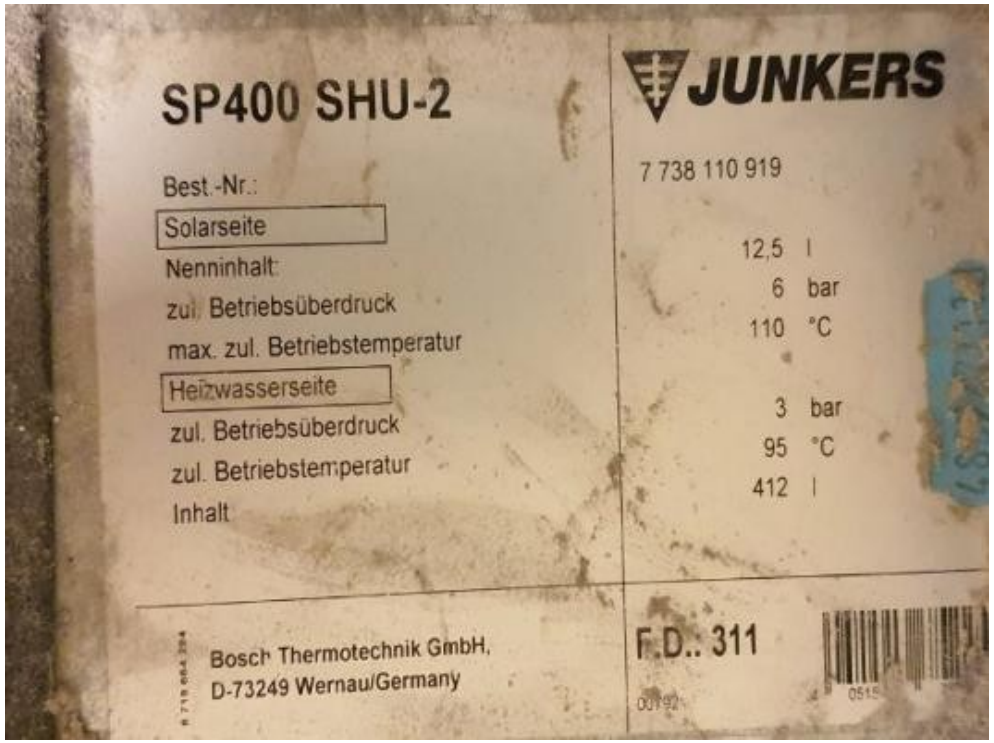
Tilt angle: β = 42.8° optimum

SolarLine collector SCM3-H Bosch

Parameters:

- η0 = 0,762
- C1 = 3,962 W/(m²K)
- C2 = 0,014 W/(m²K)
- Aperture area = 2,43 m²
- Gross area = 2,55 m²
- Fluid : water/glycole
- Connection: parallel

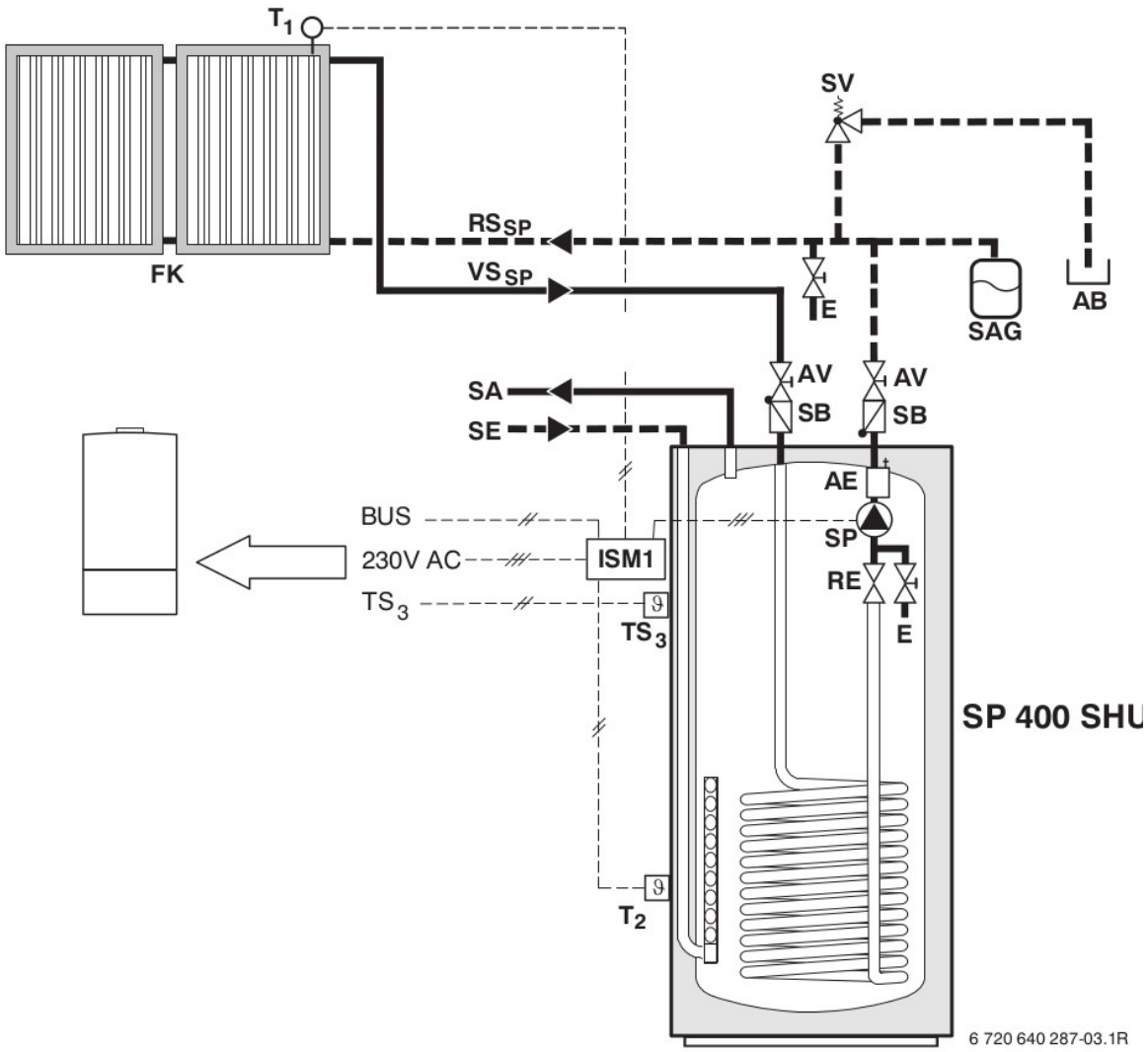
System configuration



manuel/datasheet:

- Flow rate: 2.5 - 3 l/min
- → 0.042 - 0.05 kg/s : 150 - 180 l/h
- Storage: 400 l total
- → capacity: ca. 78 l/m²

System configuration



230V AC	Spannungsversorgung vom Heizgerät zum Solarmodul
AB	Auffangbehälter
AV	Absperreinrichtung
BUS	BUS-Verbindung Solarmodul zum Heizgerät
E	Entleerung/Befüllung
FK	Kollektor
AE	Automatische Entlüftung mit Verschlusskappe
RE	Durchflussmengenmesser mit Einsteller und Anzeige
RS_{SP}	Solarrücklauf vom Speicher zum Kollektor
SA	Speichervorlauf vom Speicher zum Heizgerät
SAG	Solarausdehnungsgefäß
SB	Schwerkraftbremse
SE	Speicherrücklauf vom Heizgerät zum Speicher
SP	Solarpumpe
SV	Sicherheitsventil
SP400SHU	Pufferspeicher für Solaranlagen
T_1	Kollektortemperaturfühler
T_2	Speichertemperaturfühler unten
TS_3	Speichertemperaturfühler oben
ISM 1	Solarmodul
VS_{SP}	Solarvorlauf vom Kollektor zum Speicher

Methods

- Determine demand & supply data
- F-Chart Method with simplifications

  Calculations: Flow rates / collector type / seriall/parallel / nr. collectors / DHW ratios / storage cap.
- Alternative collector type criteria:

  Evacuated and Similiar η0 and gross area

Methods

Evacuated Tube Collector: EUROTHERM SOLAR PRO 15R

Parameters:

- η0 = 0,726
- C1 = 1,668 W/(m²K)
- C2 = 0,017 W/(m²K)
- Aperture area = 1,4 m²
- Gross area = 2,35 m²
- Fluid : water

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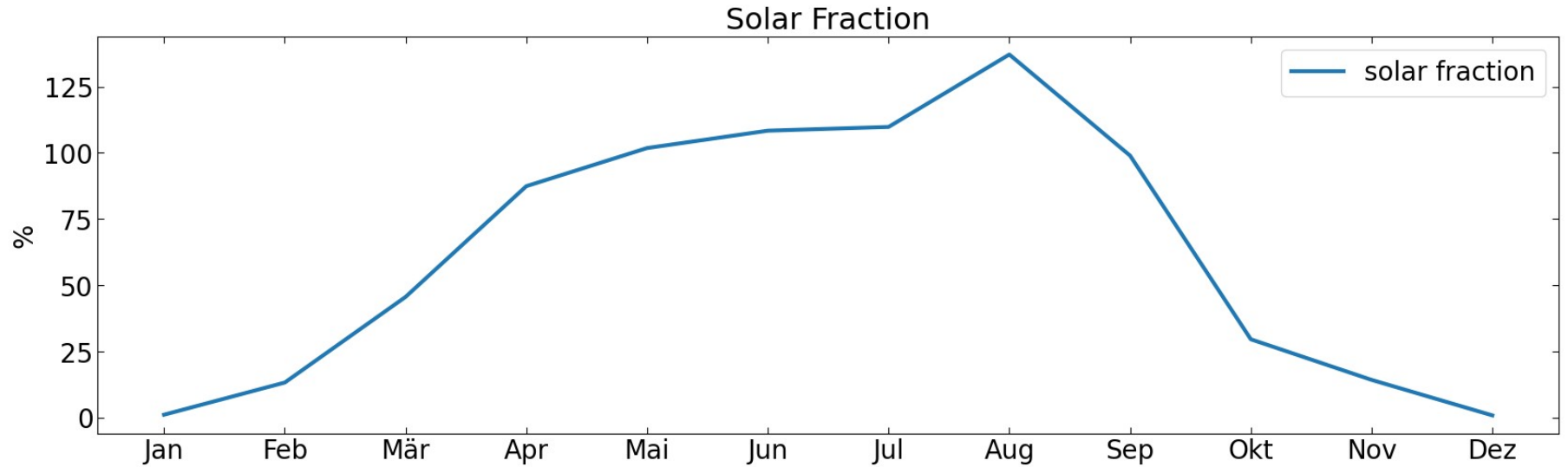
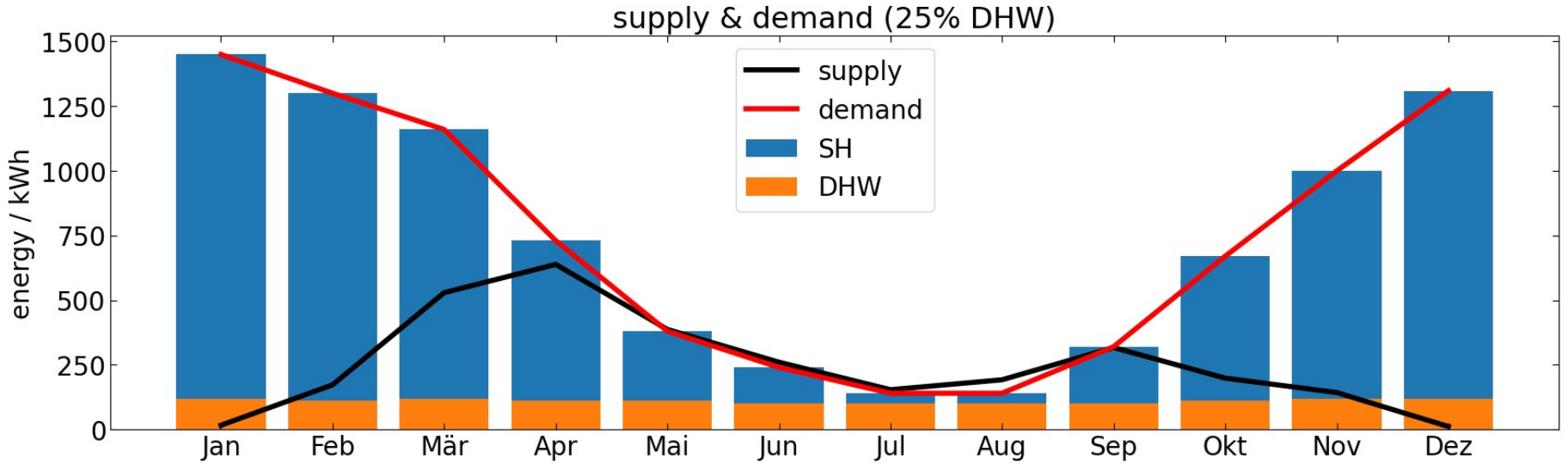
Results & Conclusion





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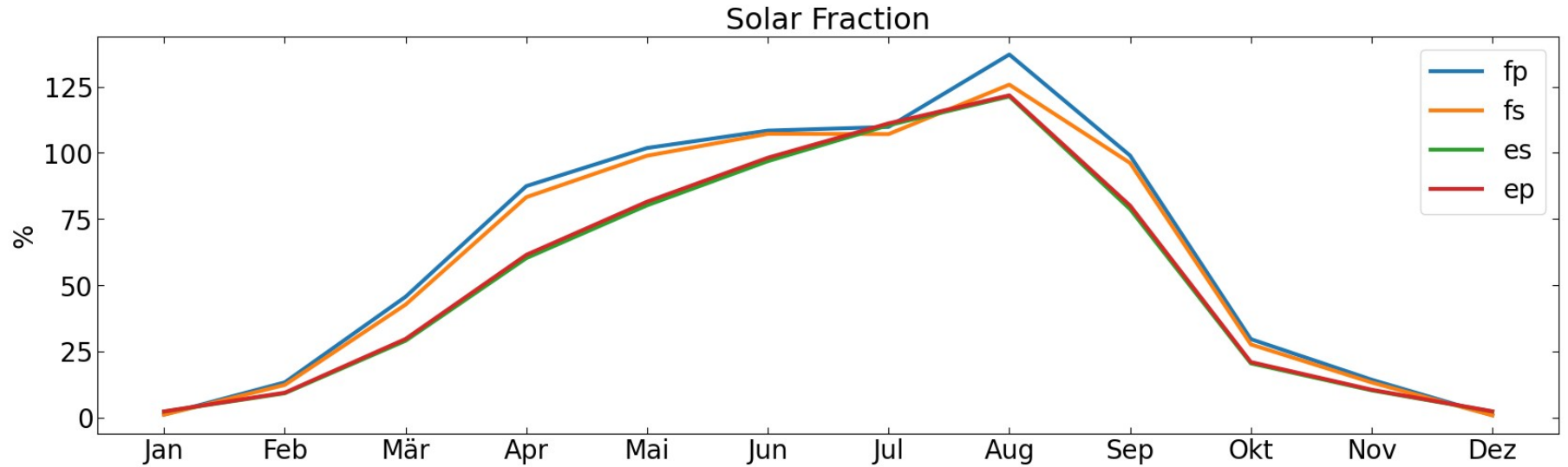

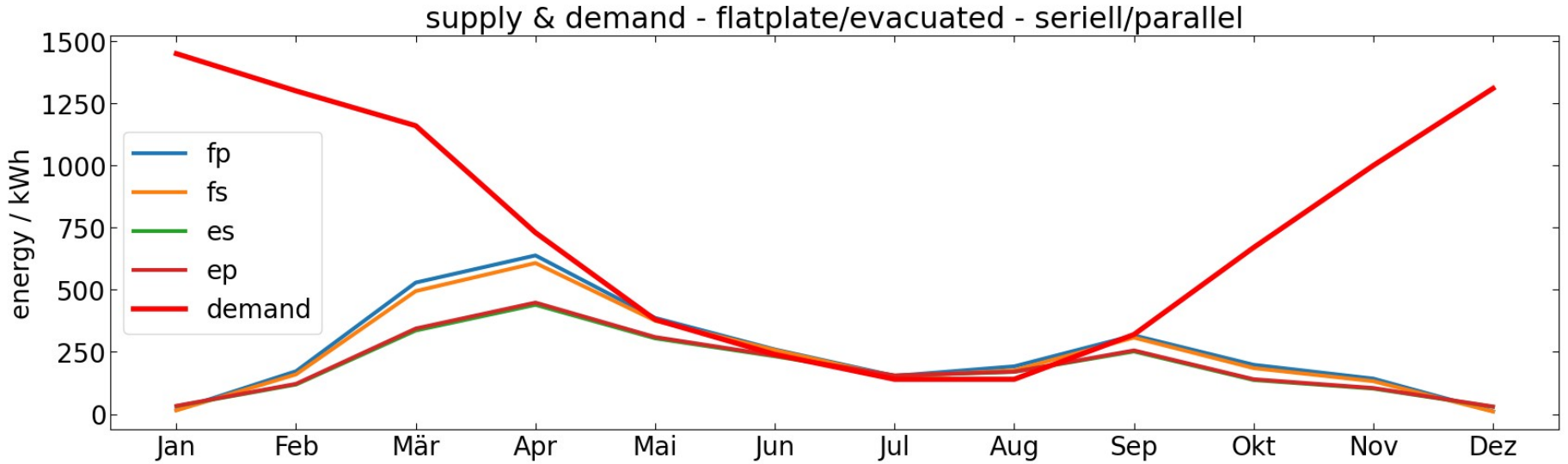

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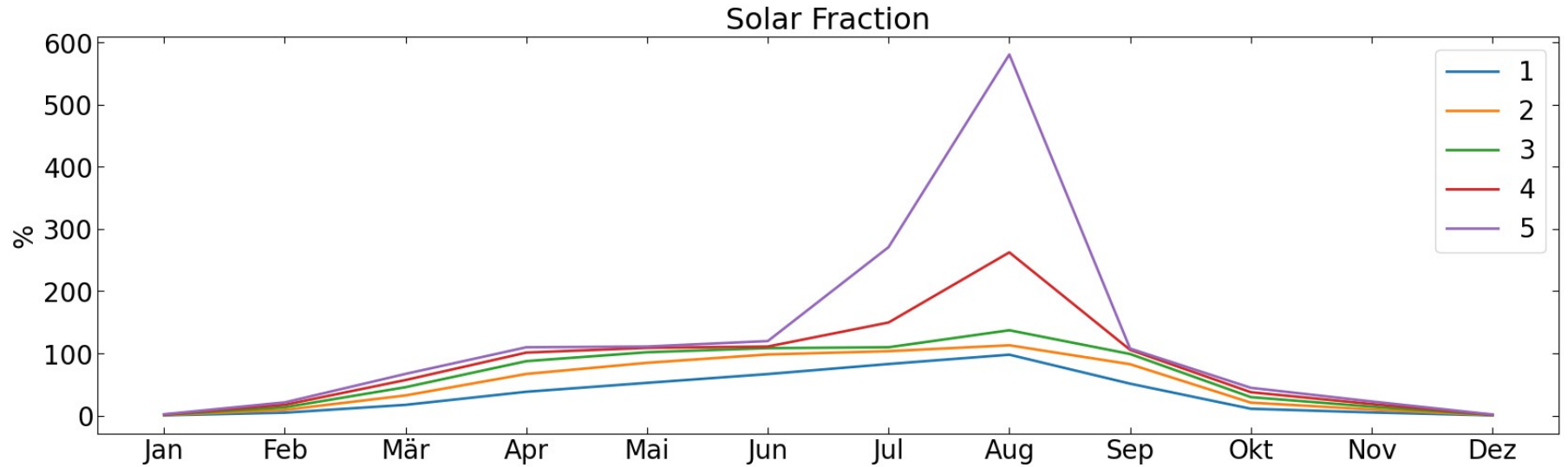

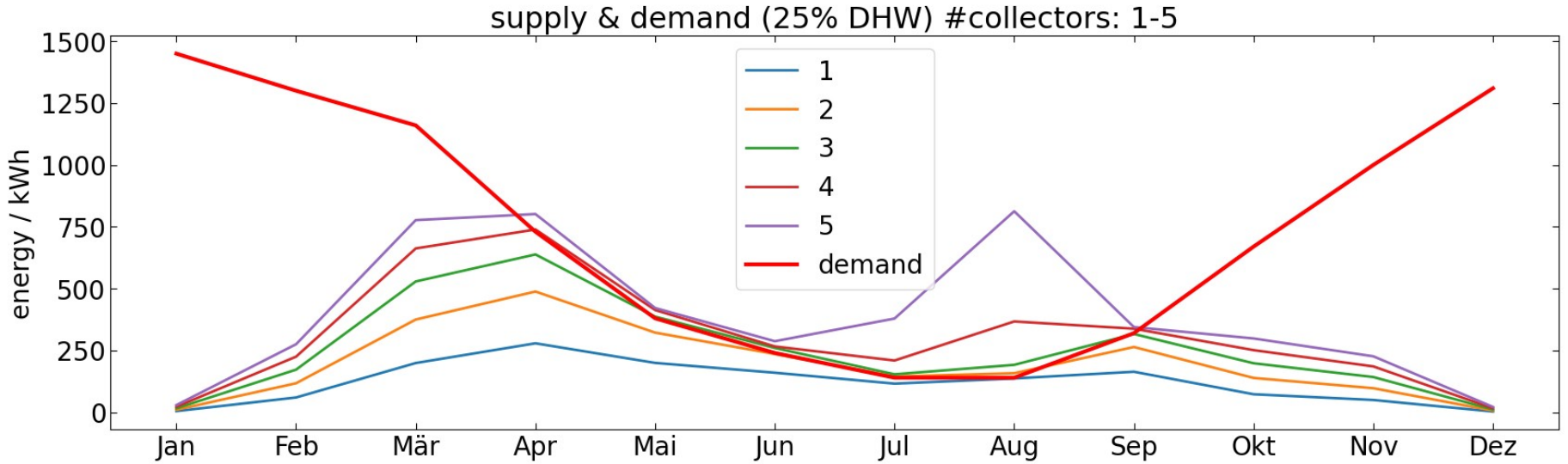

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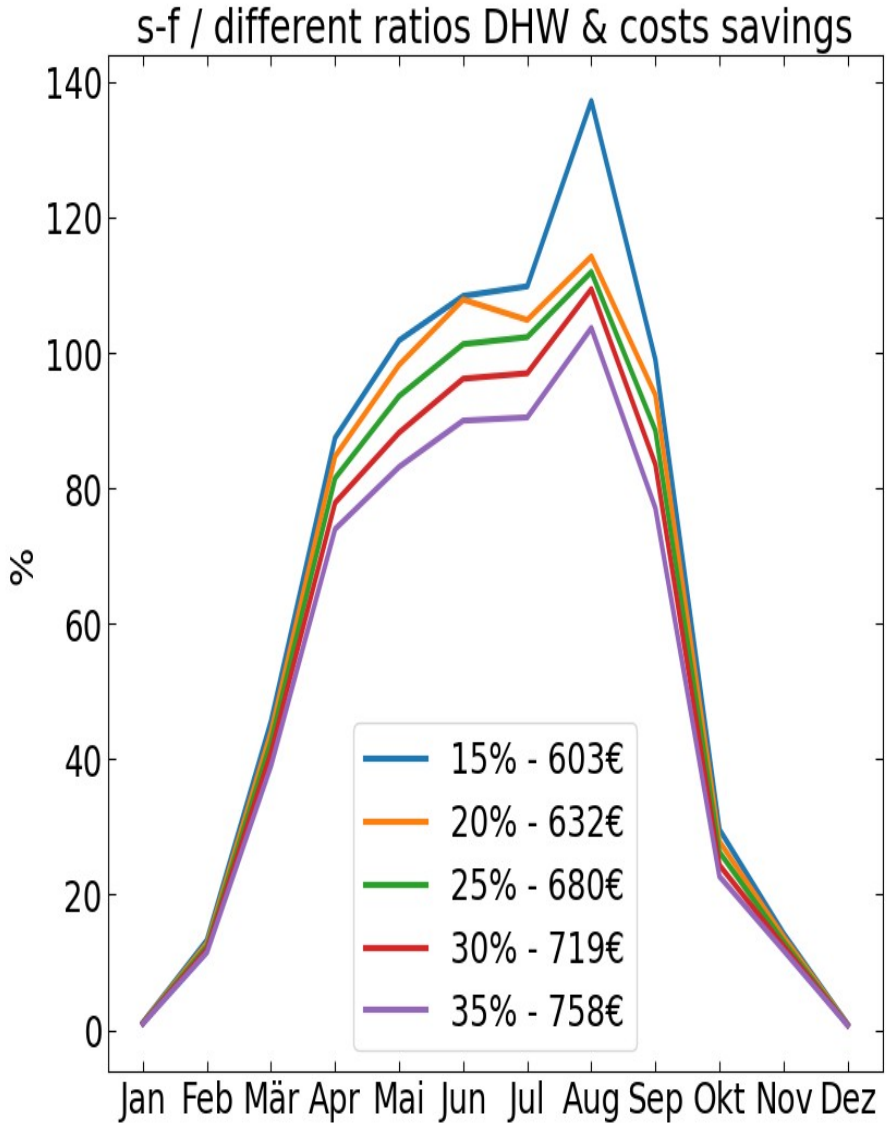

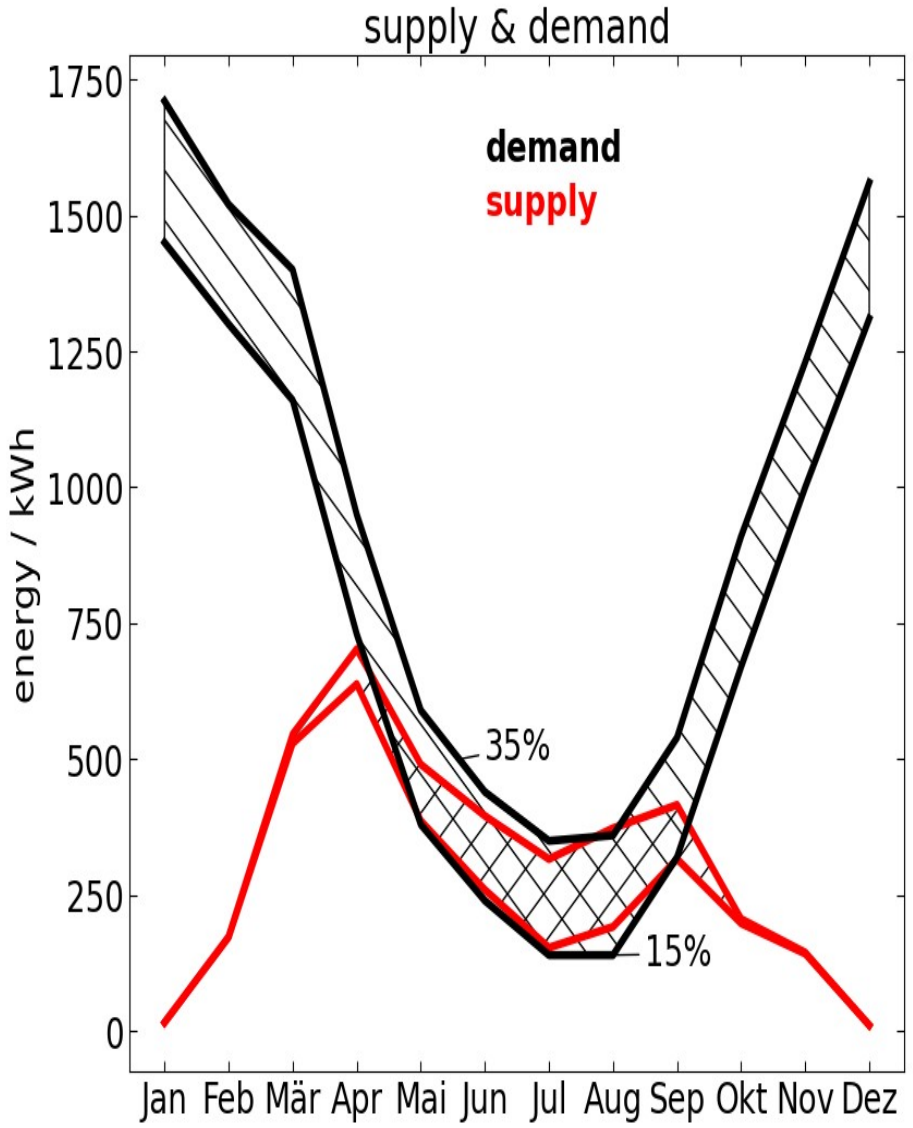

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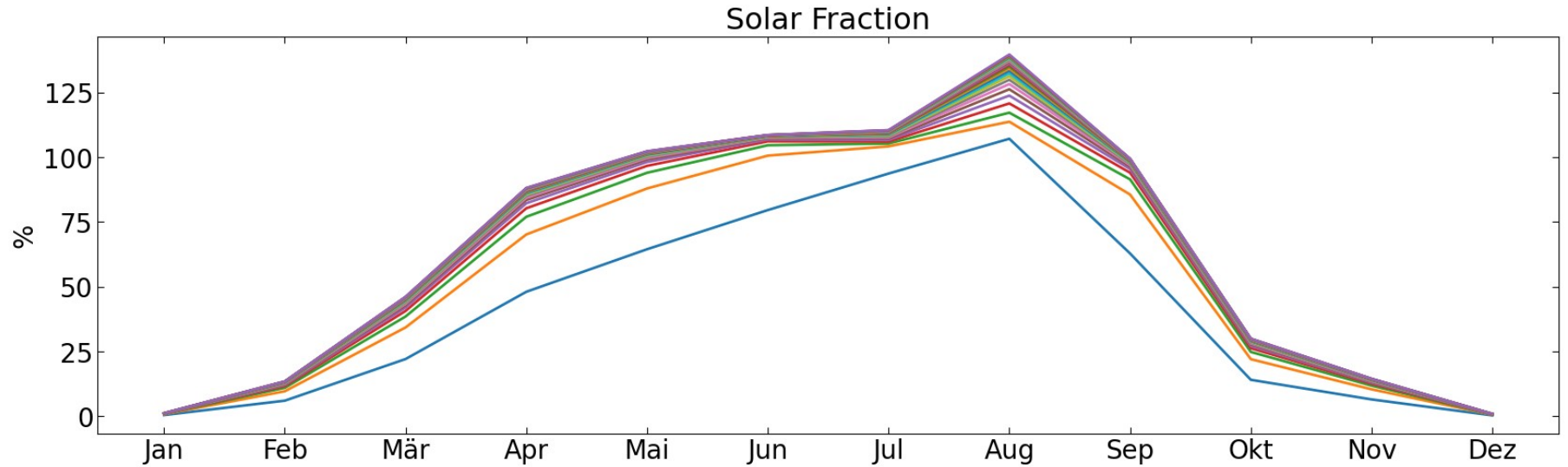

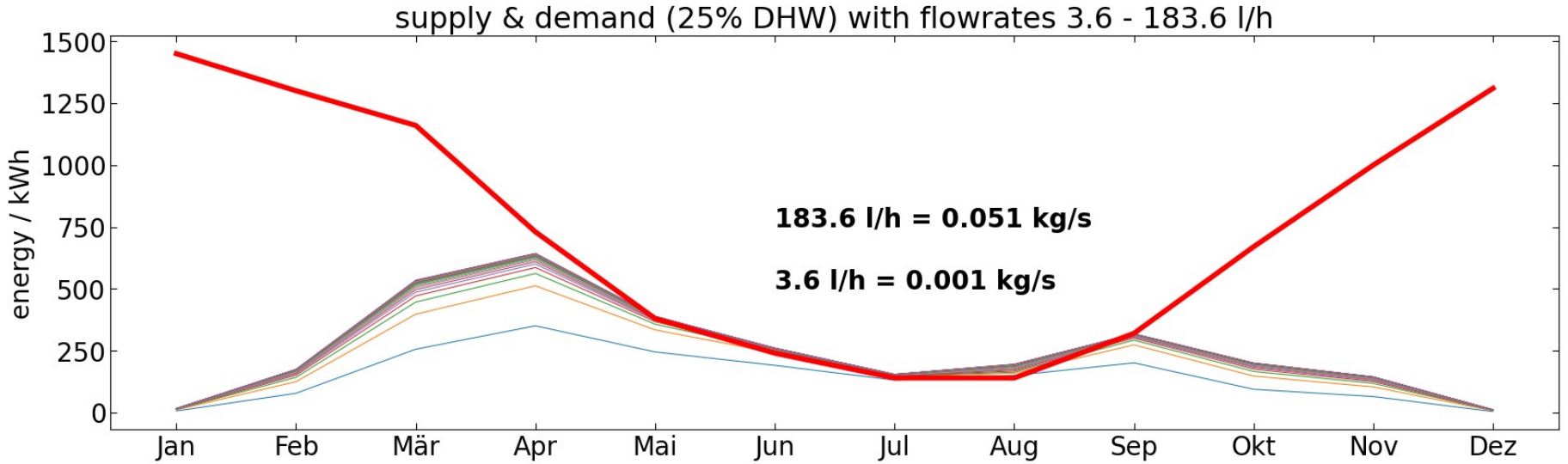

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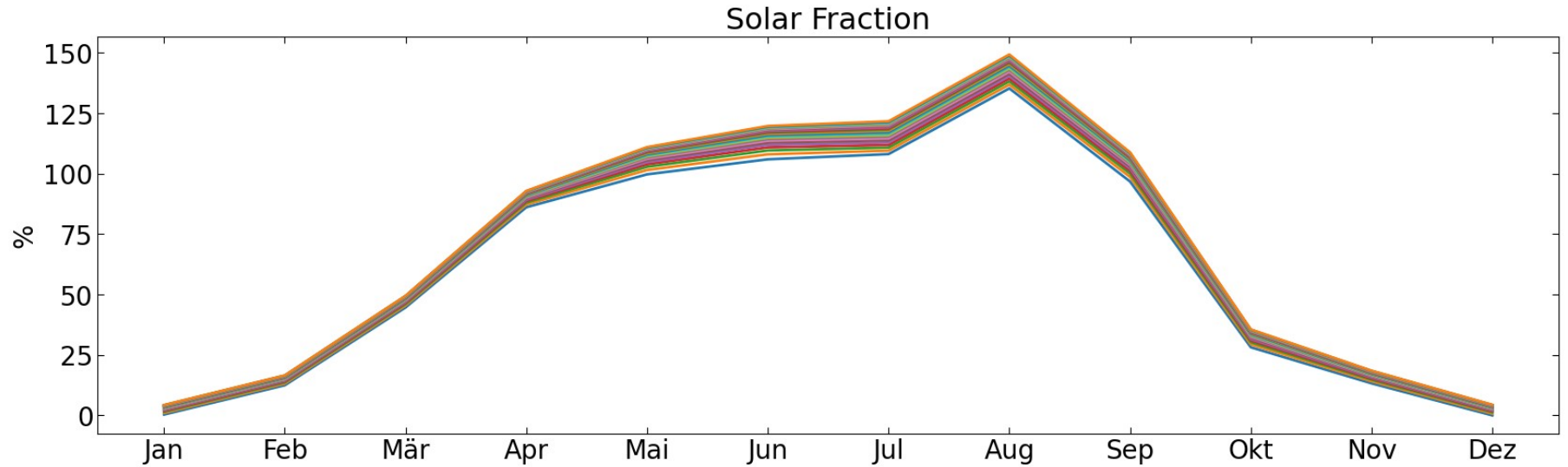

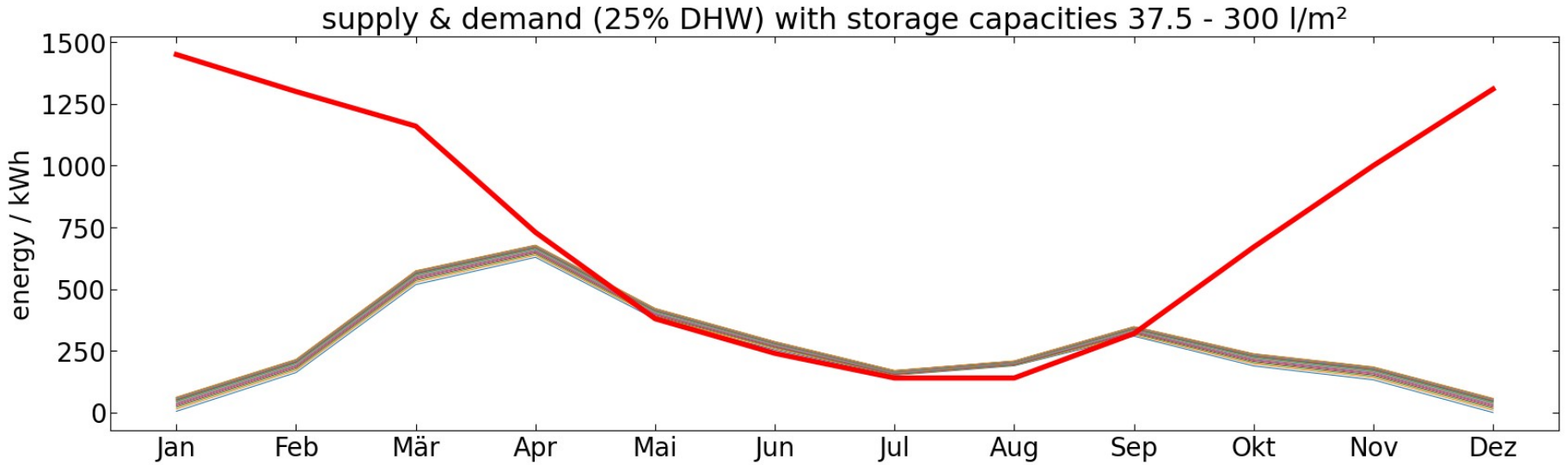

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Discussion

- Limitations:

  Specific heat capacity of collector fluid → 3,5 kJ/(kg*K)
  water/glycole depends on concentration & temperature

  Fluid temperatures not considered

  Collector alignement considered best possible

  Correction factors simplified to 1

- F-Chart Method itself an estimation → deviation up to 10%
- Seasonal storage possible with 5 collector due excess energy?

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Thank you.

Questions?