Performance Analysis of Solar Thermal Collector on W016A Lecture Hall

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Motivation

- **Sustainability Drive**: We aim to contribute to a carbon-neutral future.
- **Cost Analysis Focus**: Our project centers on a detailed cost analysis, crucial for sustainable solutions.
- **Financial Viability Study:** Evaluating different-sized solar thermal systems for insights into their financial feasibility.

Heat Demand

Table 1. Dimension of W16A lecture hall

Dimension of the W16 bulding room 004		
Length	12.5	m
Widths	8.5	m
Height	3	m
Room Area	106.25	m²

- **Average Annual Heating Demand**: Approximately 60-80 kWh/m²/year [1]
- Heat demand depends on seasonality, which is divided into three periods as follows:
  - Winter months: Average of 125 kWh/m²
  - Transitional months: Average of 70 kWh/m²
  - Summer months: Average of 7.5 kWh/m²
- **Total demand per year:** Approximately 73.6 kWh/m²

Table 2. Monthly heat demand in Lower Saxony area [1]

Heat demand in Lower Saxony region, for a room of 100 m²		
Winter months (December to Febuary)	90-160	kWh/m²
Transitonal months (March, April, October, November)	60-80	kWh/m²
Warmer Months (May to September)	5-10	kWh/m²

Panel Orientation

Solar panels will be strategically placed on the W16A building's roof directly over the lecture hall room.

Tilted at a fixed angle of 40° and facing south (azimuth angle 180 degrees)

Visual representations will illustrate these adjustments, ensuring efficient year-round energy capture.

Panels would be connected in series as needed.

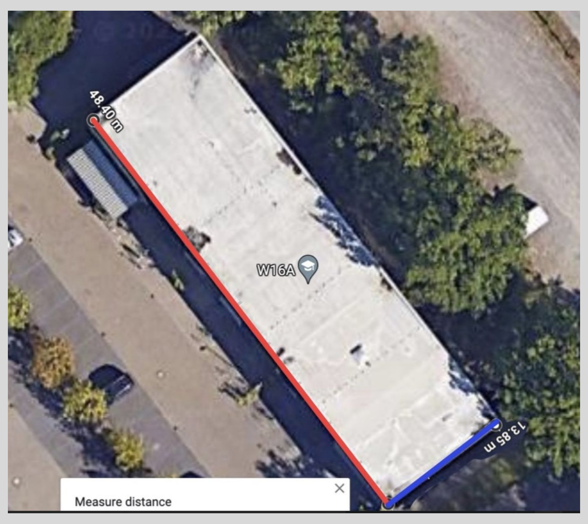

Figure 5: Meriaura Energy Panel [3]

Results

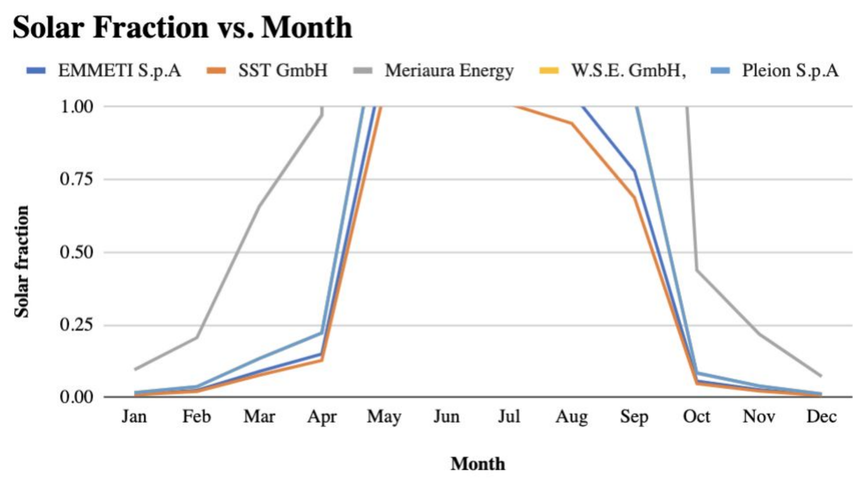

Figure 5: All Panels' Solar Fraction

Table 4: Total Solar Fraction per Year (%)

	Total Solar Fraction
EMMETI S.p.A Unipersonale	42.89
SST GmbH	41.20
Meriaura Energy Oy	63.82
W.S.E. GmbH, 011-7S3125F	46.24
Pleion S.p.A., 16083Rev.2	46.24

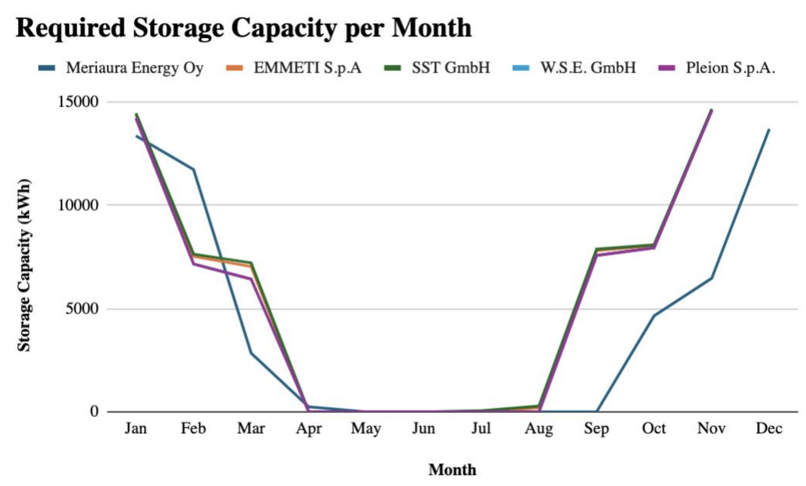

Figure 5: Storage Capacity [4]

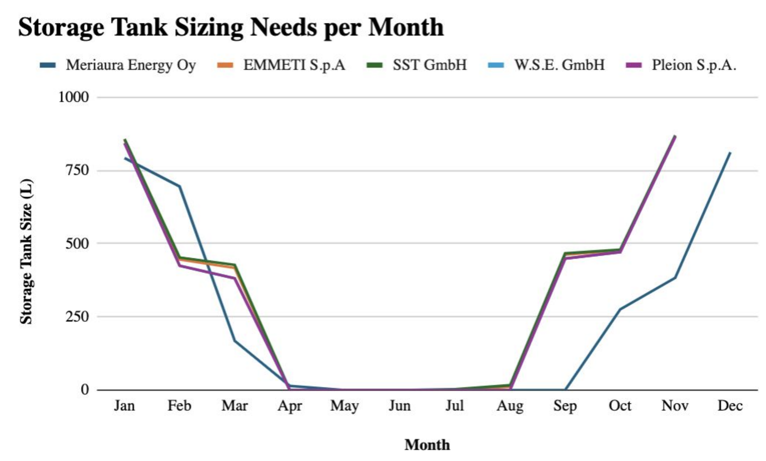

Figure 5: Storage Size [5]

Different Panel Specifications

Table 3. Solar collectors license holder company and details[2]

Company	Area(m²)	η0	α1	α2	ṁ
EMMETI S.p.A Unipersonale	2.23	0.719	3.806	0.013	0.02
SST GmbH	1	0.669	3.782	0.014	0.02
Meriaura Energy Oy	15.96	0.839	3.63	0.003	0.02
W.S.E. GmbH, 011-7S3125F	2.01	0.728	4.194	0.01	0.02
Pleion S.p.A., 16083Rev.2	2.68	0.6173	0.85	0.009	0.02

Chosen Panel Specifications

- License holder: Meriaura Energy Oy, model SAVO 16S B
- Size: 15.96 m² (2.59x6.16)
- Collector type: Flat plate collector
- Types of mounting: On stand
- Optimum tilt angle: 40° (Radiation database, PVGIS-SARAH2)

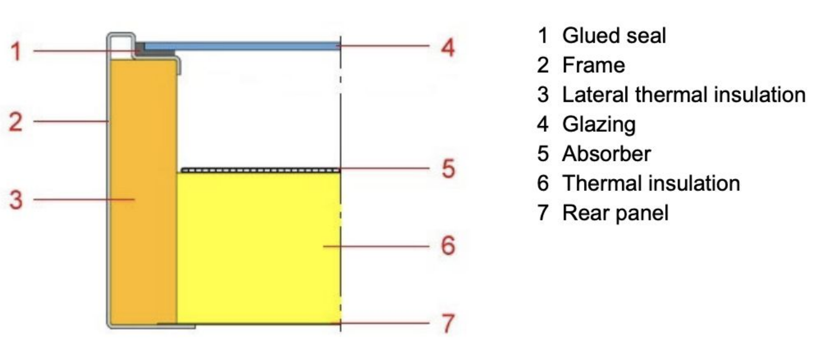

Figure 5: Meriaura Panel Construction [3]

Figure 5: Meriaura Energy Panel [3]

Chosen Panel Results

The average of the lower and higher-end cost estimates for a 15 m² solar thermal system ~ $2,625.
Thermal storage with an efficiency of 90% , the average cost, based on the estimated lower and higher-end ranges, ~ $1,750.

Table 5: Meriaura Panel Analysis

Total Solar Fraction (%)	
63.82	
Minimum Storage Requirements	
Storage Tank Size (L)	811.78
Required Storage Capacity (kWh)	13682.49

Conclusion

Given these considerations, the results from the F-chart analysis should be viewed as a preliminary estimate. They are useful for getting a general sense of the system's performance across different times of the year but may not fully capture the nuances of actual operating conditions. For detailed planning or performance evaluation, a more comprehensive analysis using specialized simulation tools would be recommended.

Meriaura Energy Oy with the highest optical efficiency, might be the best choice but an alternative panel could be the Pleion S.p.A. since it has the lowest heat loss coefficients, which might be advantageous in colder climates or during cooler months that occur in Oldenburg, Germany.

Next steps would be to evaluate the cost-effectiveness of these two panels to determine overall value of each panel and determine how many panels would be suitable.

References

[1] In-text citation: (Chat GPT, 2024)
[2]https://solarkeymark.eu/database/
[3] https://serv.spf.ch/spftesting/collectors/pdfs/scf1883en.pdf
[4]https://homemicro.co.uk/download/lzc_buffer.pdf