Title: Evaluation of an indirect solar water heater in Mashhad's climate

Abolfazl Asgari, Navid Ajam, Azadeh Momenifar
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Carl von Ossietzky Universität Oldenburg

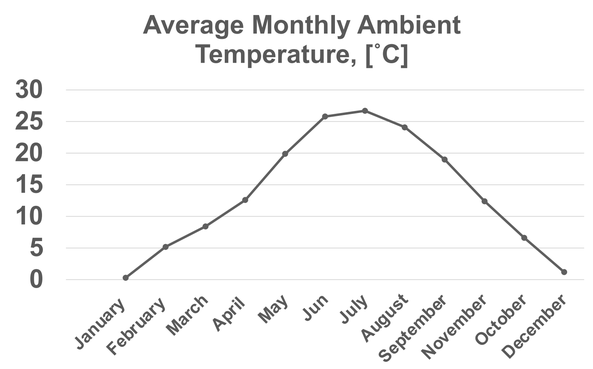
Introduction

An indirect solar water heater is a sustainable and efficient solution for Mashhad, with its hot summers and cold winters providing ample sunlight for operation. This technology aligns with global renewable energy trends and local energy efficiency needs. Evaluating its performance in Mashhad's climate is essential to understand its feasibility and benefits in an urban environment.

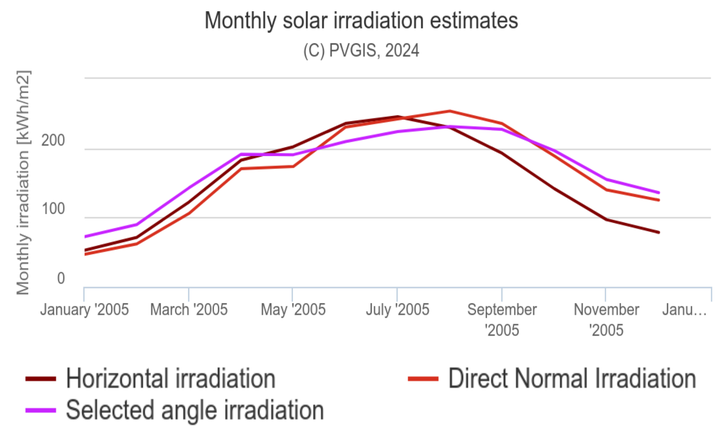
Location and meteorological data

CITY	LATITUDE	ELEVATION	LOGITIUDE
MASHHAD	36.2	1004 M	59.6

Average Monthly Ambient Temp

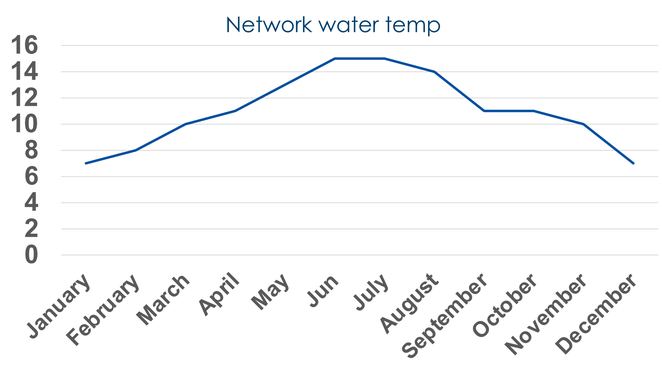


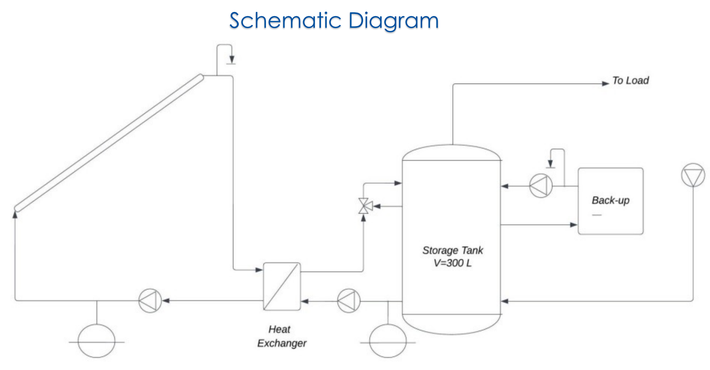
Average Monthly Radiation



Project description

Water network (T)	Demand (T)	Demand volume	Collector's tilt angle
7 – 15 (c)	**50**	**240 Litter/Day**	**36**



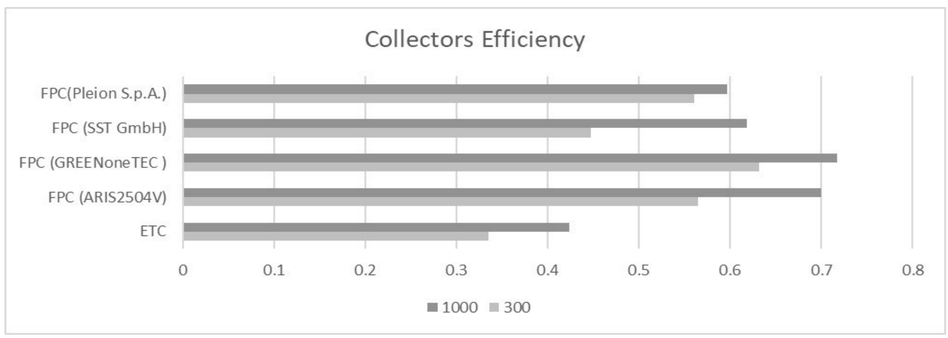


Solar collector selection

solar collector parameters

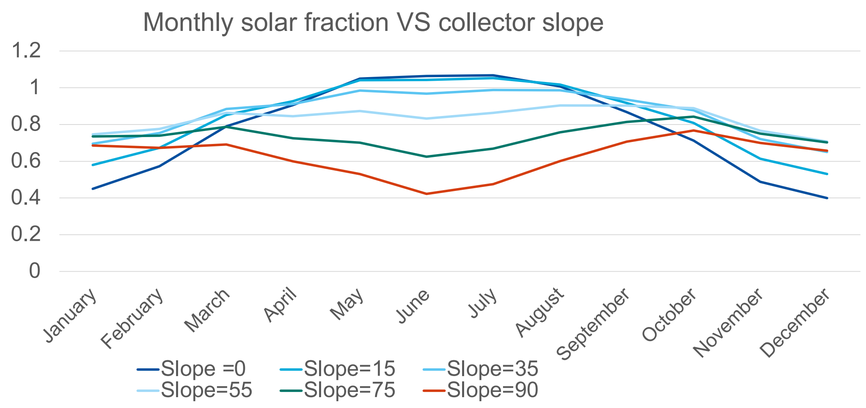
FPC (GREENoneTEC)	Flat plate collector
Zero Efficiency	0.763
a_1	1.969
a_2	0.015
Flow rate	0.02
heat transfer medium	Water-Glycole
Collector aperture area (m^2)	7.41
Collector Gross area (m^2)	7.91
Reference area	Gross

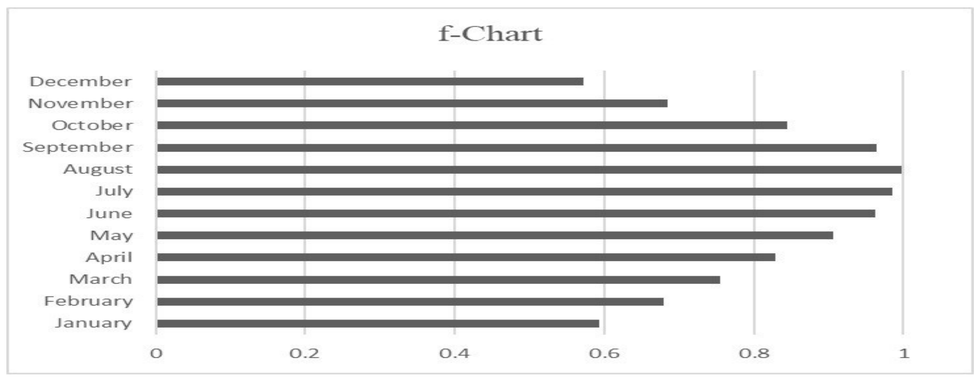
Collectors Efficiency



Number of Collector : one

Solar Fraction & F-Chart





Conclusion

- There is considerable potential for implementing this type of solar energy system in the specified location, indicating promising adaptability and benefits.
- The system designed has demonstrated satisfactory performance, meeting the expected criteria for efficiency and reliability.
- The size of the solar collectors significantly influences the system's effectiveness, with larger areas generally enhancing solar energy capture.
- Performance fluctuates with changes in the tilt angle of the solar collectors, suggesting an optimal angle may exist that correlates with the location's latitude.
- A well-matched slope of the collectors to the location's latitude can optimize performance, indicating a direct relationship between geographic positioning and system efficiency.
- Varying the volume of the storage tanks has a notable impact on system performance, highlighting the importance of appropriate sizing to meet energy demands.

References

- Mathematical description of F-chart and Utilizability Methods for solar thermal system sizing and analysis
- https://solarkeymark.eu/database/
- https://re.jrc.ec.europa.eu/pvg_tools/en/