Table 3: Climatic data for different climatic zones of India

Climate	Rep. City	Annual Radiation	Mean Temp.
Hot & dry	Ahmedabad	9.89 GJ	28.0
Moderate	Bangalore	9.23 GJ	23.6
Composite	Delhi	9.12 GJ	25.3
Cold & sunny	Leh	6.22 GJ	5.50
Warm & humid	Madras	9.83 GJ	28.6
Cool & cloudy	Srinagar	8.88 GJ	13.4

required gave the collected energy of each day. The sum of this value for 365 days gave the annual energy collected. Table 4 shows the energy collected by all five types of collectors in the six cities.

Table 4: Energy collected in six cities of India (in GJ/year)

City	Type I	Type II	Type III	Type IV	Type V
Ahmedabad	4.73	4.98	4.49	4.83	6.73
Bangalore	4.31	4.54	4.08	4.41	5.84
Delhi	4.32	4.56	4.17	4.44	5.99
Leh	1.54	1.58	1.59	1.63	1.89
Madras	4.67	4.86	4.40	4.71	6.23
Srinagar	4.19	4.41	3.85	4.26	4.97

5 Energy Payback

The pay back period for different types of collectors in different climatic zones has been shown in **Table 5**. Despite the same energy content of Type I & III and Type II & IV their pay back periods are different as their outputs are different.

Table 5: Payback period (yrs.) of different types of systems in six cities of India

Rep. City	Type I	Type II	Type III	Type IV	Type V
Ahmedabad	1.24	1.18	1.47	1.37	0.73
Bangalore	1.36	1.29	1.62	1.50	0.84
Delhi	1.36	1.29	1.59	1.49	0.82
Leh	3.81	3.72	4.16	4.06	2.60
Madras	1.26	1.21	1.50	1.40	0.79
Srinagar	1.40	1.33	1.72	1.55	0.99

6 Conclusions

The analysis of solar water heating has revealed that the evacuated tube collector system has about 16% less energy content than single glazed and 26% less energy content than double glazed flat plate collectors. Due to reduced losses, it also delivers 20-30% more output than all other types in different climatic conditions considered in this analysis. The payback period is nearly one year for the system having evacuated tube collector as compared to about 1.5 years for other types, for all the stations other than Leh. Leh has relatively higher payback, but the evacuated tube type has the least payback period in such climate also. This suggests that the use of the evacuated type collector system should be promoted irrespective of the climatic conditions. Among the flat plate collectors, a single glazed collector with selective coating is the most suitable for Indian climatic conditions. The above analysis has purposely not been extended to find the energy yield ratio as the expected lifetime of different solar water heating systems may be different and reliable information regarding their lifetime in various climatic zones of India was not available to the authors. However, considering an average lifetime of the considered systems to be 15 years in India gives the energy yield ratio ranging from 3.60 for the system having a double glazed collector with black paint in Leh to 20.47 for a system with an evacuated tube collector in Ahmedabad.

7 References

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Erratum

Linear Programming as a Tool in Life Cycle Assessment
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Vol. 3, No. 6, p. 308, Eq. 11
Please note the correct reproduction of Eq. 11 below:

$$B_j = \sum_{c=1}^{C} \lambda_{j,c} e_c$$