LOW TEMPERATURE SOLAR THERMAL DOMESTIC HOT WATER POTENTIAL OF CROATIA'S ISLAND AND COASTAL REGIONS

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INTRODUCTION

Solar thermal (ST) energy for the supply of domestic hot water (DHW) is a cost-effective alternative to conventional energy resources in Croatia. Applications for private housing and tourist accommodation facilities are discussed. Increasing electricity demand and import especially during the summer season and supply problems on islands support the relevance of alternative energy sources in Croatia [1].

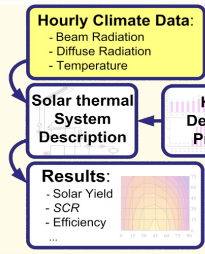


Fig.1: Simulation scheme with relevant input parameters and results

1. METHODS

System analysis and optimization is based on sensitivity analyses on annualy based data, see Fig.1 [2]. Climate data sets are synthetic annual data generated from Meteonorm [3]. Weekly and annual demand profiles scale the nominal daily demand down by a percentage.

- **Systems are designed for SCR = 70%**
- **Three climate data sets: *Rijeka, Zadar, Hvar***
- **One system for private housing (SFH f)**
- **Three systems for tourist accommodations: (ACC S, ACC M, ACC L)**

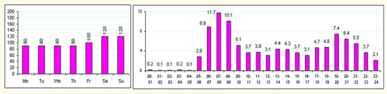


Fig.2: Weekly (left) and Daily (right) DHW demand profiles

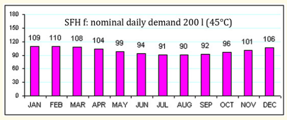
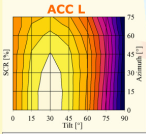


Fig.3: Annual DHW demand profile for private housing (SFH f);

2b. SYSTEMS FOR TOURIST ACCOMMODATION



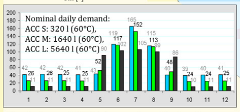
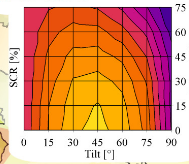


Fig.4: Annual DHW demand profile for three tourist accommodations, derived from statistical data

	ACC S Priv. accom.	ACC M Camp	ACC L Hotel
A_{field} [m²]	7.66	36.39	130.22
Storage [l]	500	2000	8000
Yield [kWh / m²]	462	404	347
SCR	74.10%	71.7	71.2
Costs [€ / m²]	553 ± 100	457 ± 48	426 ± 48
IPBT [years]	14.5	16.5	16

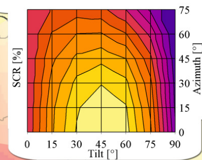
2a. SYSTEMS FOR PRIVATE HOUSES

RIJEKA: 1.41 MWh/m²



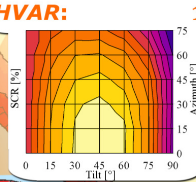
Single family system, SFH f
- A_{field} = 5.75 m²
- **DHW storage**: 300 l
- **Specific yield** = 434 kWh/m²
- **SCR = 68.3 %**
- **Specific costs** = 570 ±95 €/m²
- **IPBT** = 16.5 years

ZADAR: 1.75 MWh/m²



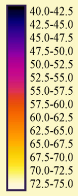
Single family system, SFH f
- A_{field} = 3.83 m²
- **DHW storage**: 300 l
- **Specific yield** = 685 kWh/m²
- **SCR** = 72.5 %
- **Specific costs** = 648 ±95 €/m²
- **IPBT** = 12.5 years

HVAR: 1.78 MWh/m²



Single family system, SFH f
- A_{field} = 3.83 m²
- **DHW storage**: 250 l
- **Specific yield** = 673 kWh/m²
- **SCR** = 72.1 %
- **Specific costs** = 609 ±95 €/m²
- **IPBT** = 12.0 years

Color map for contour plots of Solar Coverage Ratio (SCR) values in [%]



BACKGROUND ILLUSTRATION: Map of Croatian coastal counties colored using METEONORM data for global annual solar irradiation. The municipalities included in the scope of this paper are shown with brighter color and local borders.

3. TILT ANALYSIS

- **Analysed systems have significantly different annual DHW heat demand profiles.**
- **The optimal tilt angle decreases as the relative off-season demand falls.**

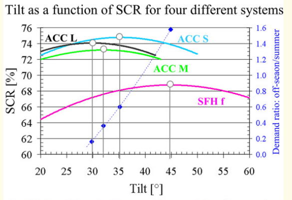


Fig. 5: Optimal tilt angles The respective cumulative off-season to summer (May-September) demand ratios, displayed on the right axis, are marked with diamonds and the dashed line shows the trend; simulated for Rijeka.

4. SPECIFIC ANNUAL YIELDS ACCORDING TO CLIMATE DATA

- **Southward Increasing**
- **Decreasing for ACC systems due to relatively low off-season demand.**

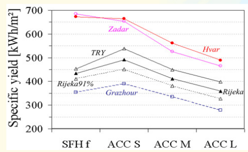


Fig.6: Specific annual yields for four systems generated with six different climate data sets, each represented by one line. *Rijeka91%* relates to data with 9% less radiation than *Rijeka* [3]; TRY cf. [4], Grazhour cf. [2].

5. SOLAR THERMAL POTENTIAL AND ECONOMICAL ANALYSIS

- **Energy conversion costs decrease significantly southwards**
- **10% of potential final energy savings amount to 36 +/- 2 GWh**

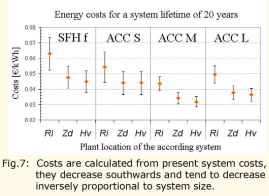


Fig.7: Costs are calculated from present system costs, they decrease southwards and tend to decrease inversely proportional to system size.

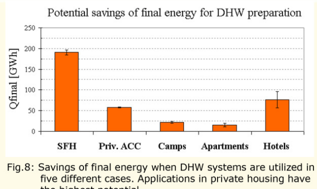


Fig.8: Savings of final energy when DHW systems are utilized in five different cases. Applications in private housing have the highest potential.

SUMMARY & CONCLUSION

- **One ST DHW system for private and three for commercial purposes were simulated for analysis along the Croatian coast**
- **The optimal tilt angle decreases highly in relation to off-season demand**
- **Specific yields are significantly higher than for middle-European regions**
- **SCR drops by 5.4 ± 1.0% for suboptimal years**
- **10% ST DHW utilization could double the current share of renewables in Croatia**
- **IPBTs are financially viable and the ST energy costs decrease southwards**

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