

Sandro Nižetić

# Hybrid air-conditioning system for applications in the Mediterranean climate

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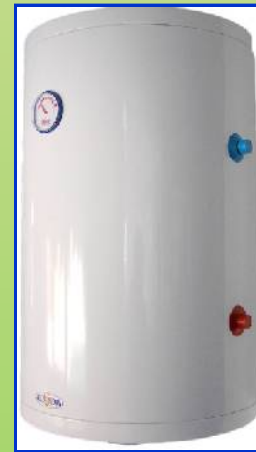
# Research motivation

- Croatia is country with typical **Mediterranean climate** (average solar insolation ranges from **1,500-1,600 kWh/m<sup>2</sup>a**),
- The main **economic branch** is **tourism**, especially on the coast side of Croatia,
- Majority of touristic building facilities are **small or medium one** regarding their size,
- More than **70%** of energy in building facilities is spent for space **heating/cooling** and **preparation of the hot water**,



## Research motivation

- Typical installed energy system in building facilities consists from **air-conditioning units** ( **split heat pump systems** that can be used throughout the whole year) and **accumulation reservoir** for preparation of the hot water with installed electric heater.



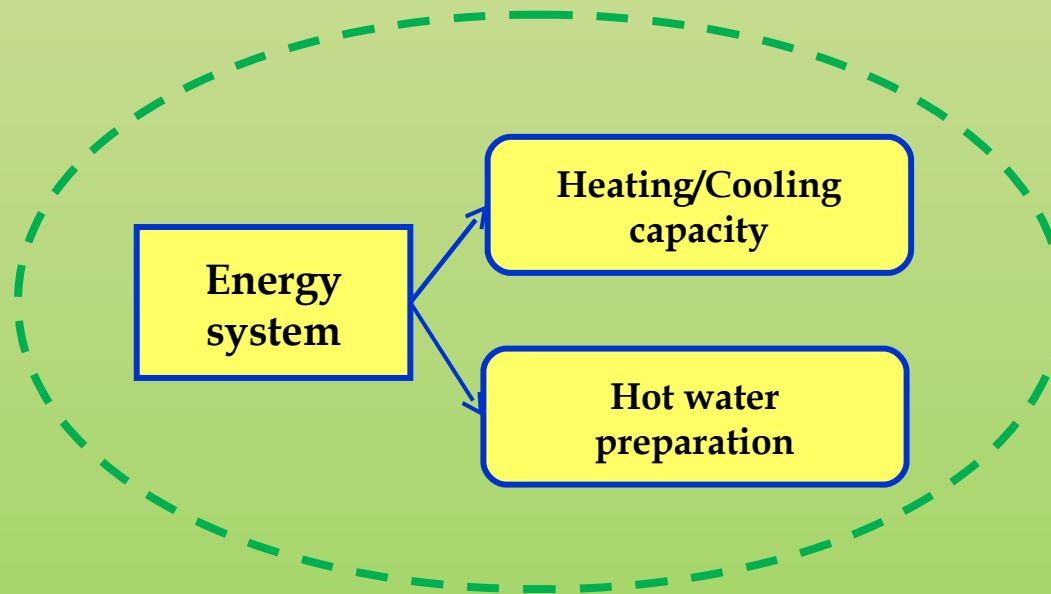
# Research motivation

- Mandatory goal is also to **preserve existing environment** through the implementation of the renewable energy technologies as much as possible.



# Research motivation

Hence the **main idea** was to assemble energy system that would ensure heating/cooling capacity with simultaneous preparation of the hot water where existing renewable energy technologies would also be used.

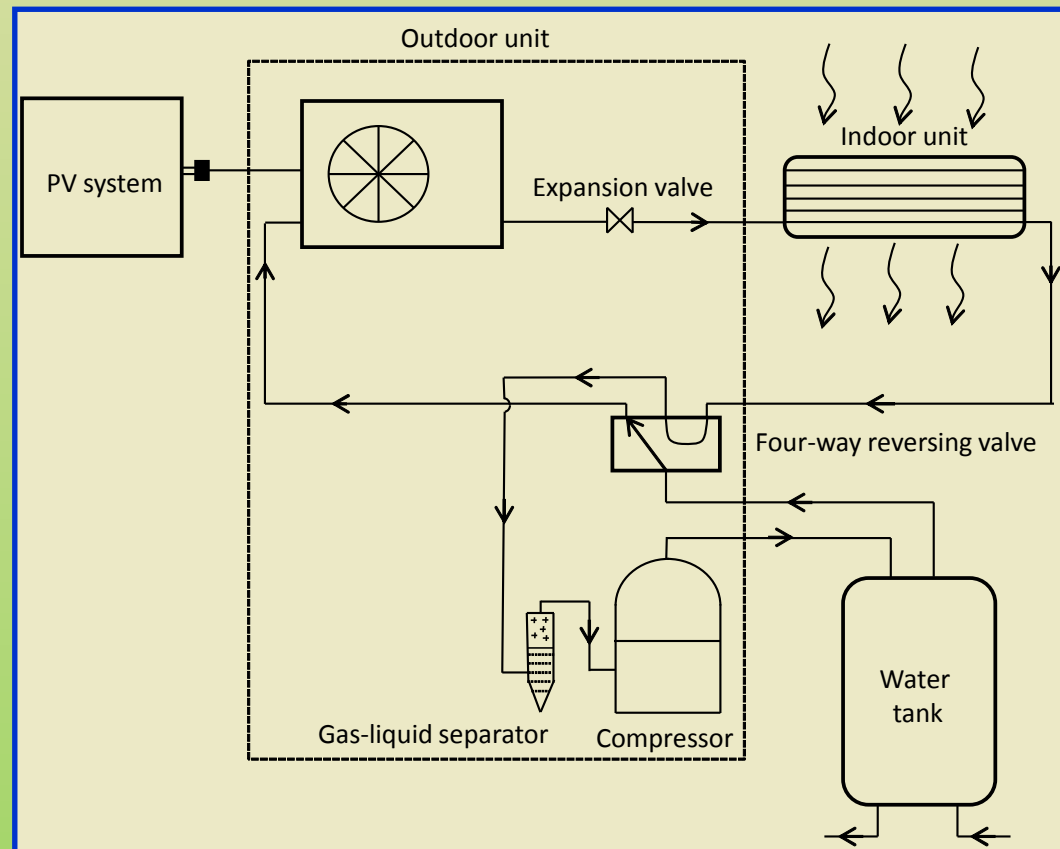


Renewable energy system  
( assembled from the market available technologies)

# Experimental setup



- **R410A** (refrigerant),
- **3.7kW/3.5 kW** (heating/cooling capacity),
- **1.8 kW** (installed electric power of the PV system,
- **4 batteries** (each 330 Ah),
- **80 lit** (capacity of the water tank).



Proposed renewable energy system for building application



# Experimental setup



Specific experimental setup of the hybrid energy system

# Experimental setup

- The system was tested during **the typical summer day** in the location of the Mediterranean climate (city of Split),
- **Hot water simulation consumption** was also tested during the experimental measurement period (around 90 liters of water was wasted).

**Initial conditions  
(daytime regime)**

Daytime working regime		
Weather conditions	Outside weather conditions: Air temperature: Wind: Precipitation:	sunny, clear 32.8°C N 6.7 m/s 0 mm
Starting conditions	Time at which measurement started: Temperature inside space: Water temperature in boiler: Set temperature of cooled space:	11:25 AM 27.6°C 33.3°C 24°C
End of measurement	Closing measurement time: Total measurement time:	15:30 PM 4.05 h



# Experimental setup

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The average achieved **performance parameters** during the **daytime** work regime:

- 
- COP (EER) : 4.6 (min.) - 6.1 (max.) (**5.4 in average**)
  - Mean water temperature: **46.6°C** (50.1°C maximal)
  - Mean engaged compressor power: **665 W** (1.135 W maximal)
  - Average Hourly electricity consumption: **0.66 kWh** per hour.
- 



# Experimental setup

- The system was tested during the typical summer night, i.e. nighttime working regime.

Initial conditions  
(nighttime regime)

Nighttime working regime		
Weather conditions	Outside weather conditions: Air temperature: Wind: Precipitation:	celar 29.3°C  0 mm
Starting conditions	Time at which measurement started: Temperature inside space: Water temperature in boiler: Set temperature of cooled space:	8:30 PM 28.8°C 33.3°C 24°C
End of measurement	Time at which measurement ended: Total measurement time:	12:30 AM 4.00 h

# Experimental setup

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The average achieved **performance parameters** during the **nighttime** work regime:

- 
- COP (EER) : 4.9 (min.) - 6.7 (max.) (**5.8 in average**)
  - Mean water temperature: **43.1°C** (47.2°C maximal))
  - Mean engaged compressor power: **552 W** (900 W maximal)
  - Average Hourly electricity consumption: **0.55 kWh** per hour.
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# Experimental setup

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## Conclusions:

➤ Presented hybrid renewable energy system has shown promising performance parameters in the cooling mode, namely;

- COP ranged in average from 5.0 to 6.0,
- average electricity consumption ranged from 0.55 kWh to 0.66 kWh/h per hour,
- average water temperature has ranged from 43°C to 47°C.

➤ Hence, presented energy solution is a potential one for small building applications, especially in the regions with problematic electricity supply and with mild climate,

➤ Increase in energy efficiency of existing used energy technologies is enabled through it's easy modification.



**THANK YOU KINDLY FOR YOUR**

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