Energy-Exergy (2E) investigation of solar drying system

Nap-Napja (SunDay)

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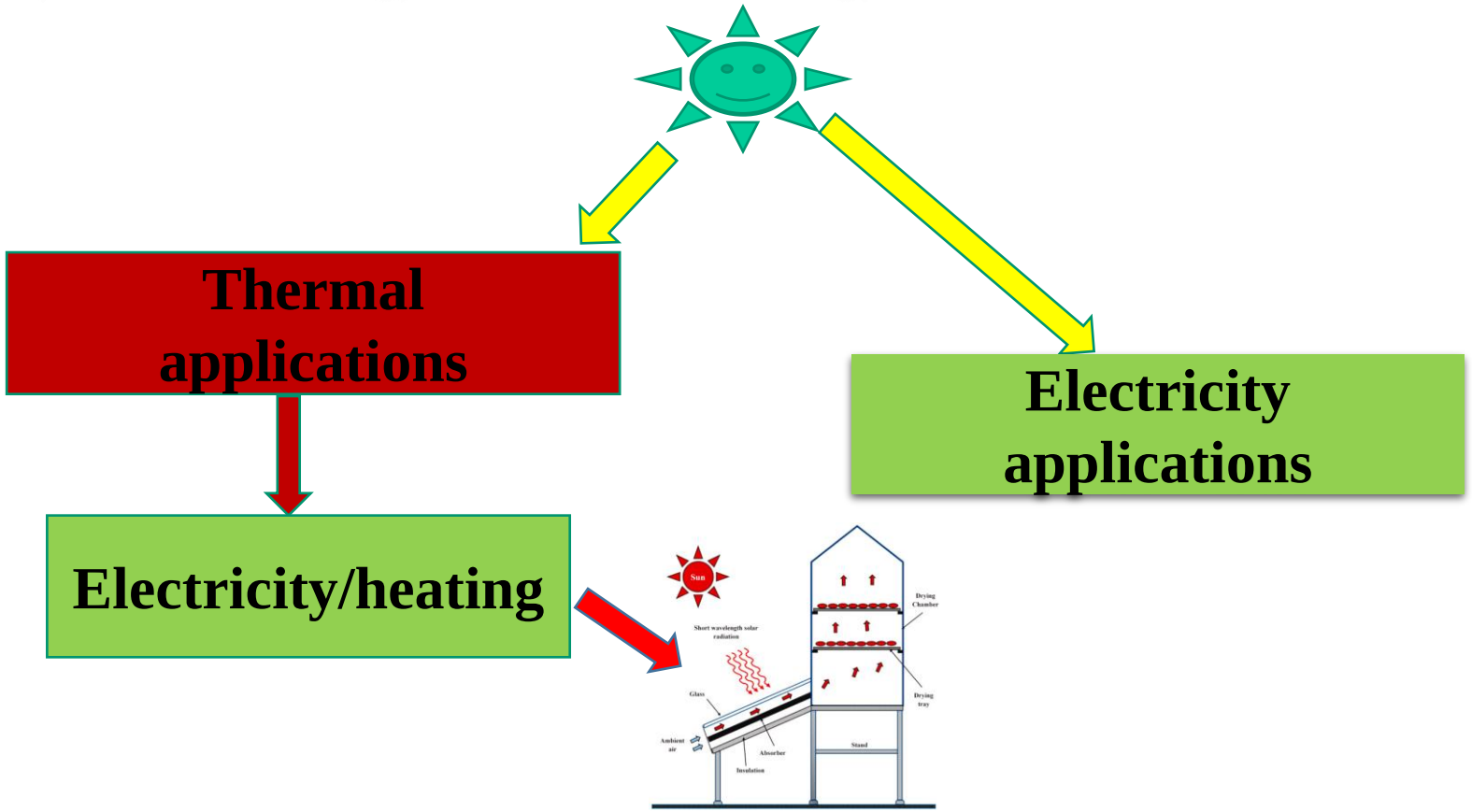
Introduction (1/2)

- The world is confronted with three major challenges: maintaining a stable and affordable energy supply, ensuring food security, and combating global warming.
- Renewable energies are promising methods to solve energy issues
- The primary source of energy for renewable energy is the solar radiation.



Introduction (2/2)

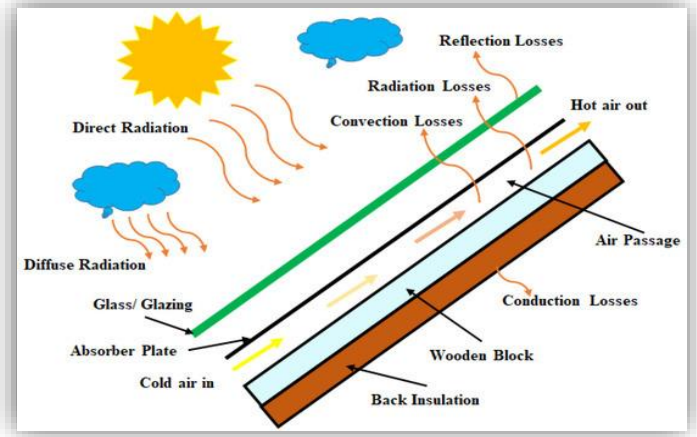
- Energy & Exergy Analysis are the most common methods for efficiency evaluation
- **Benefits of Energy Analysis**

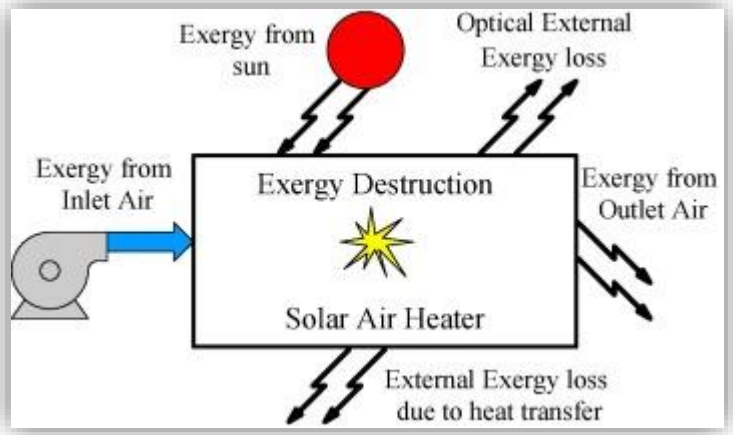
✓Identifies energy consumption patterns

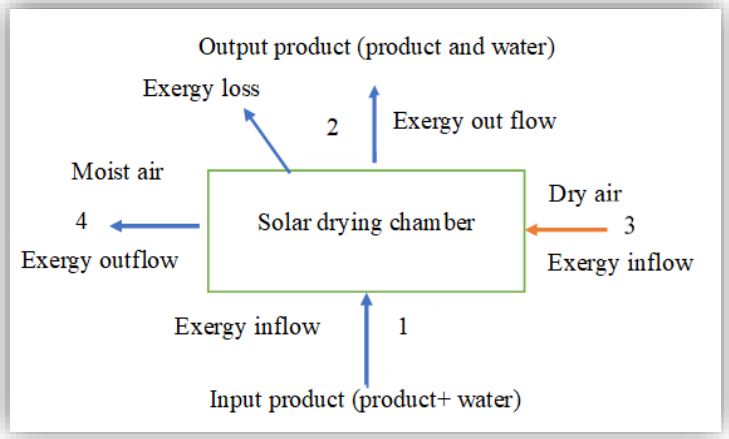
- **Benefits of Exergy Analysis**

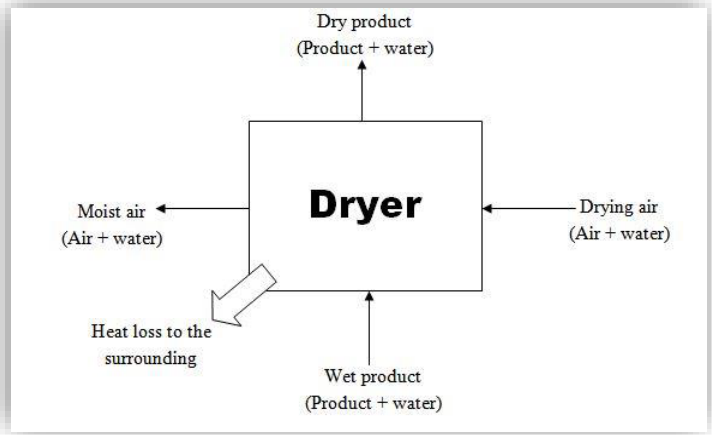
✓Provides deeper insights into system performance.

- Energy analysis: best for basic energy audits
- Exergy analysis: best for advanced optimization & innovation



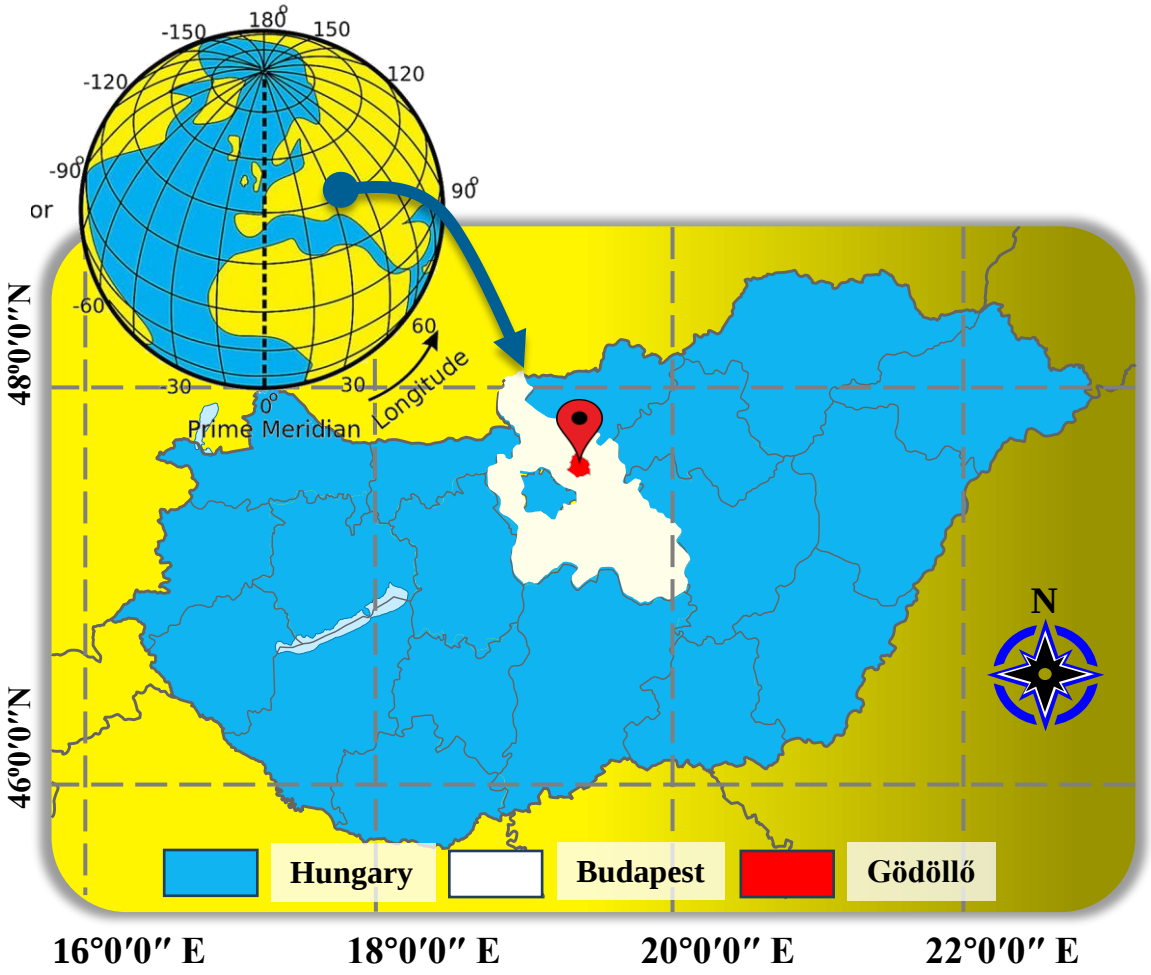






Material and methods (1/2)

Study location



Solar energy laboratory (MATE, Gödöllő, Hungary)

Measurement instruments

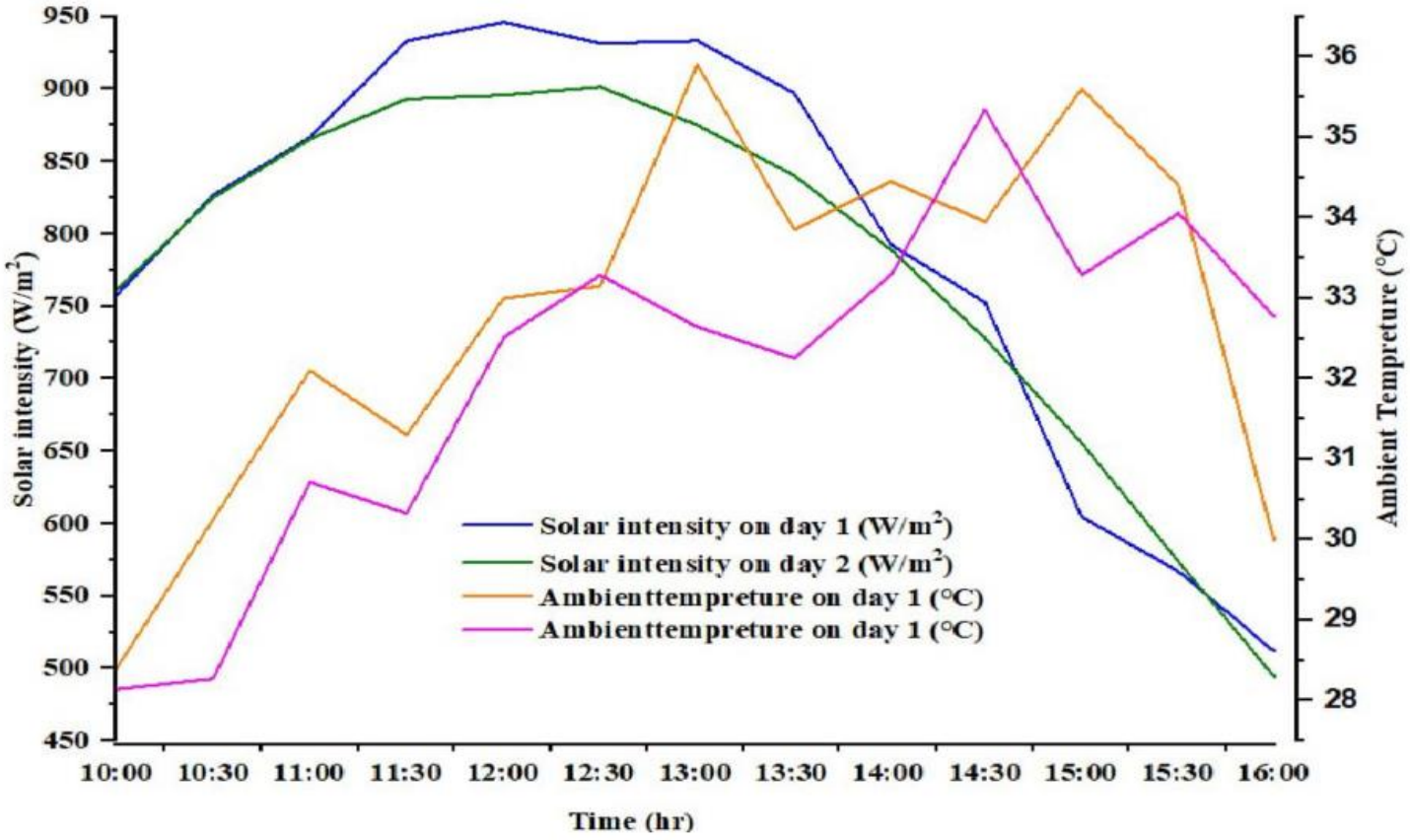
NATIONAL INSTRUMENTS LabVIEW

ADAM TECH
ADVANCED INTERCONNECT PRODUCTS AND SYSTEMS

Result and discussions(1/4)

Solar Radiation Trends:

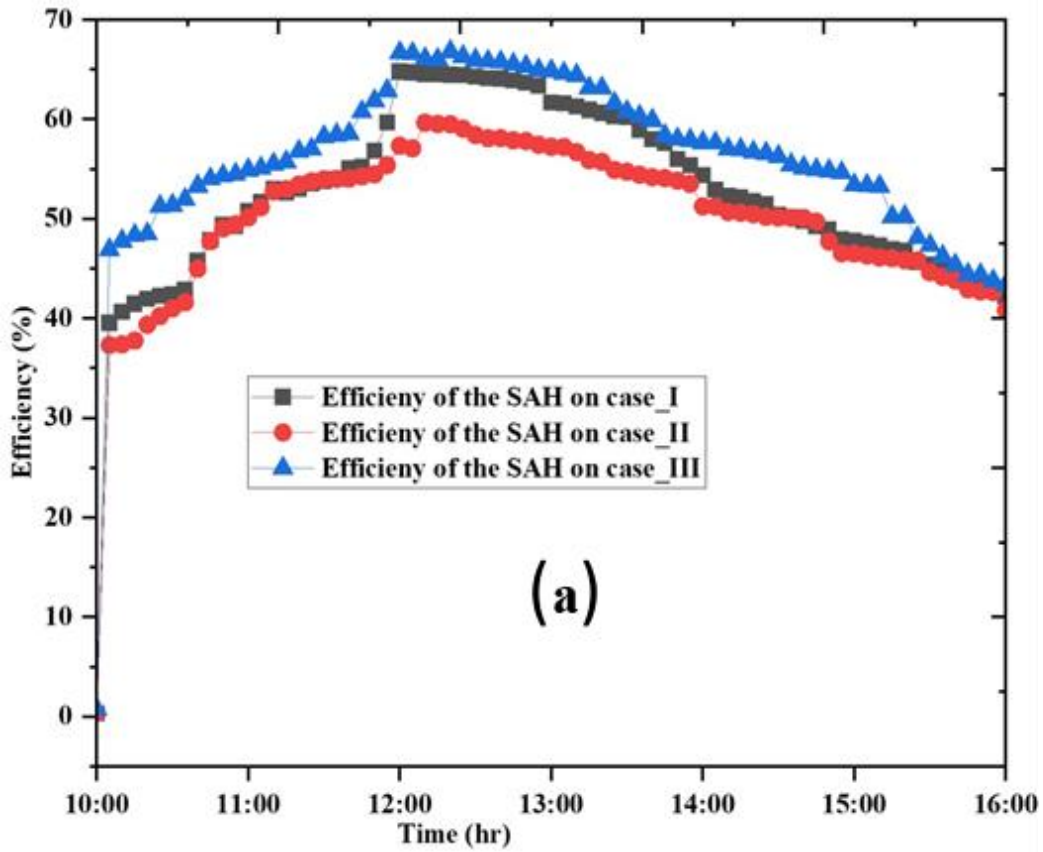
- Morning: Gradual increase
- Midday: Peak intensity
- Afternoon: Steady decline

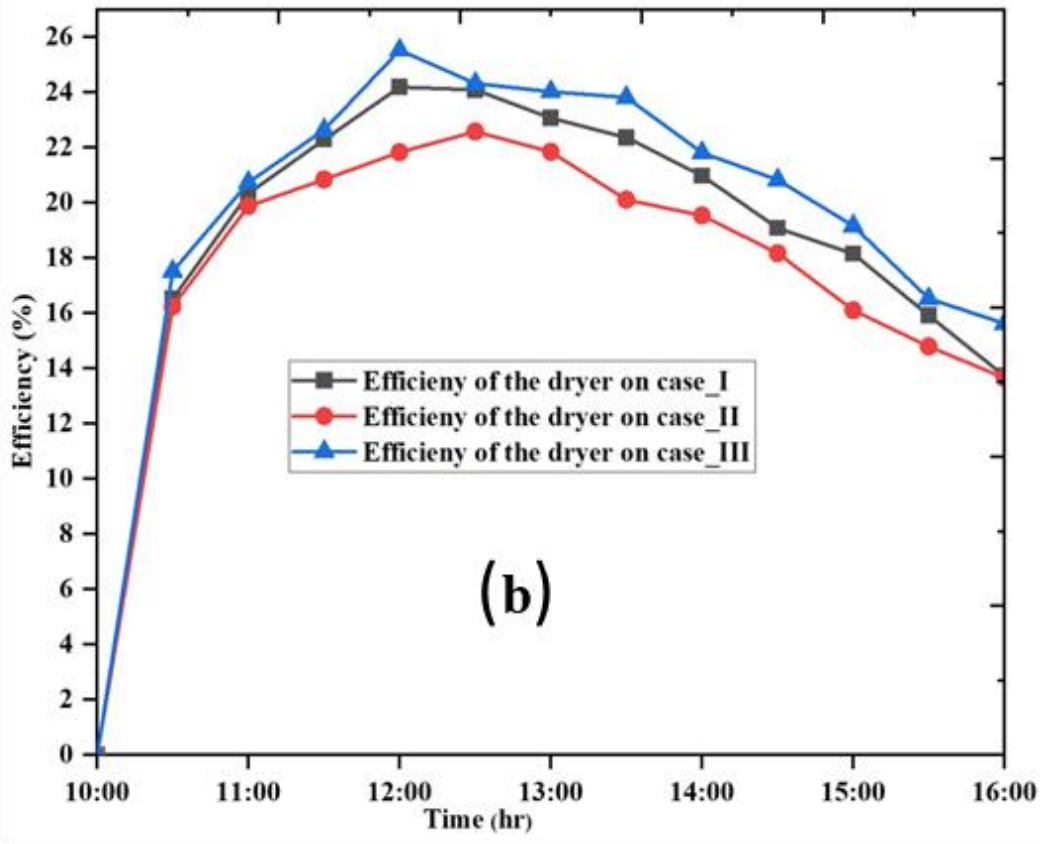


Results – Thermodynamic performance analysis (2/4)

Energy analysis

- ❖ Solar air heater and dryer exhibit nearly identical trend patterns
- ❖ Both systems follow expected thermal trends





Energy analysis of SAH(a) and drying chamber (b)

Results – Thermodynamic performance analysis (3/4)

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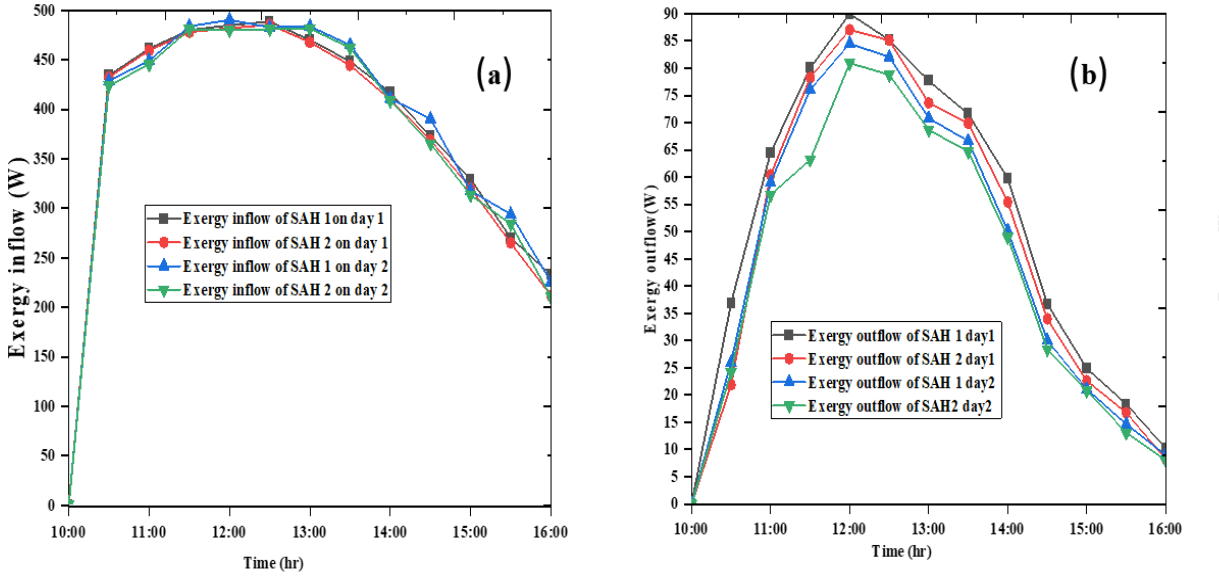
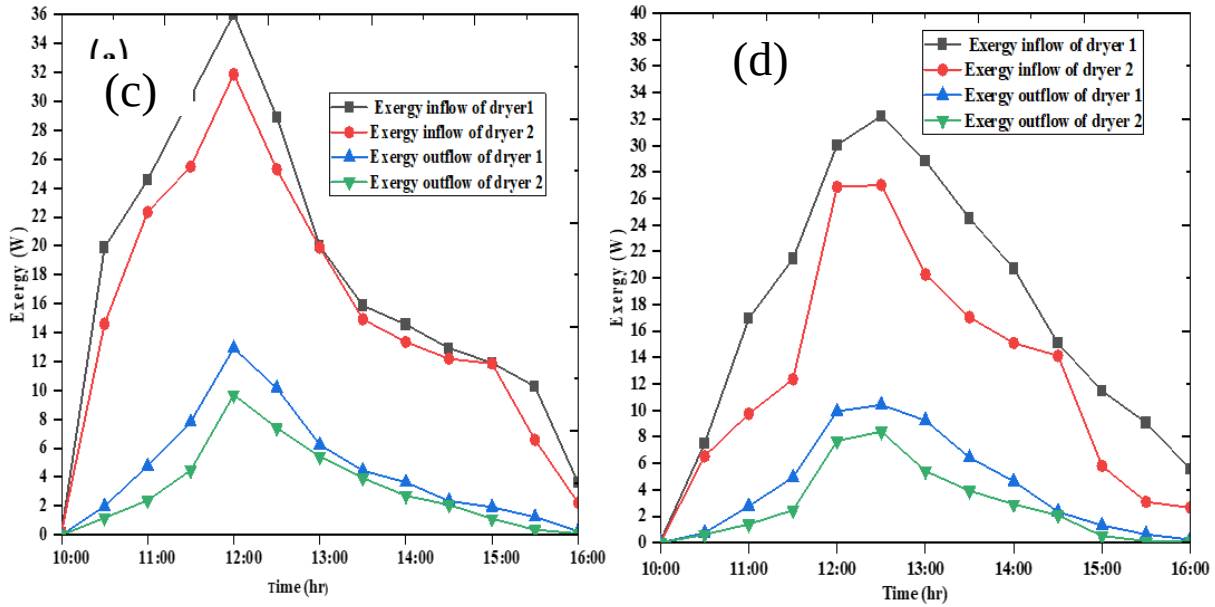
Exergy analysis of the drying system

- ❖ **Peak exergy inflow at midday, gradual afternoon decline observed**
- ❖ **Exergy rises with solar radiation**



Exergy inflow of (a) and exergy outflow (b) of the solar air

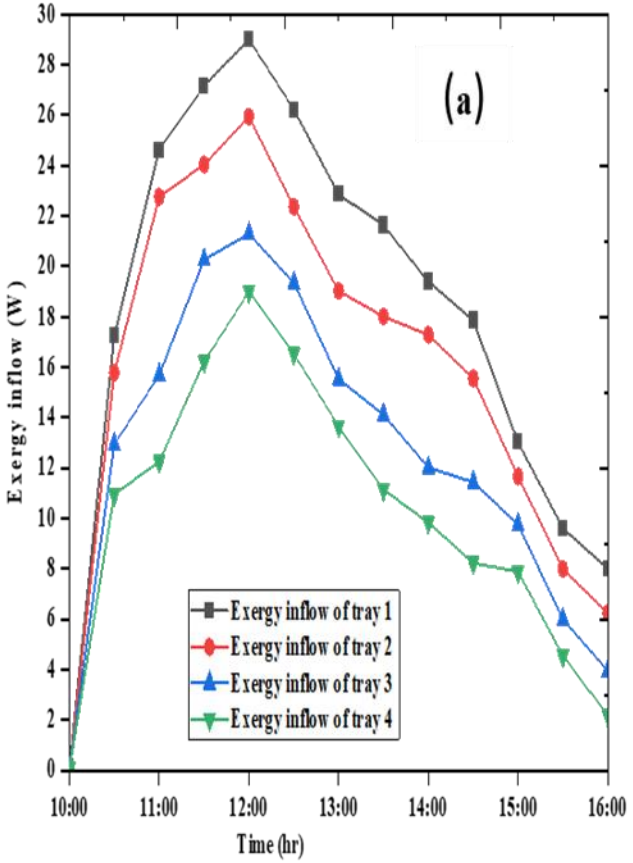


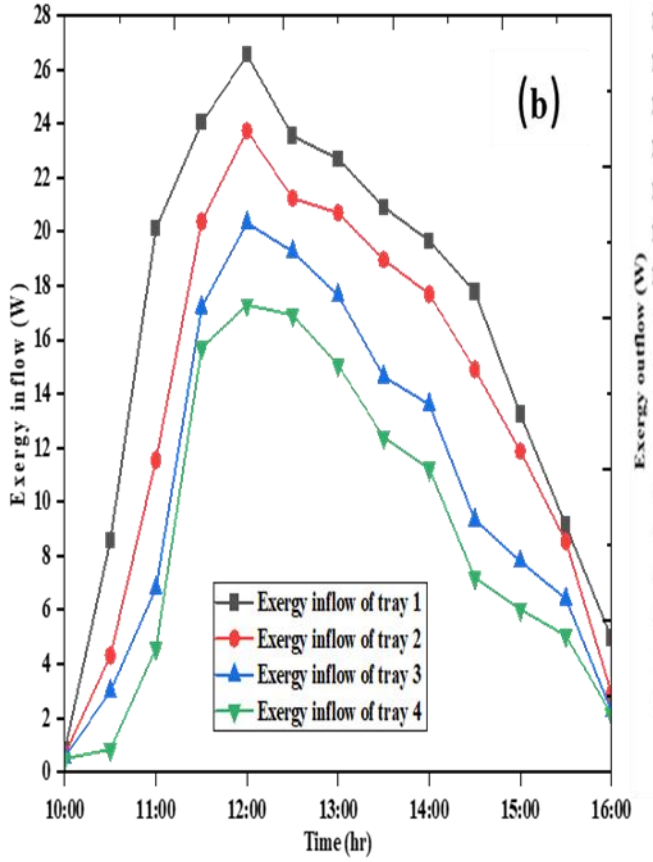
Exergy analysis of the drying chambers: day 1 (c) and day 2 (d)

Results – Thermodynamic performance analysis (4/4)

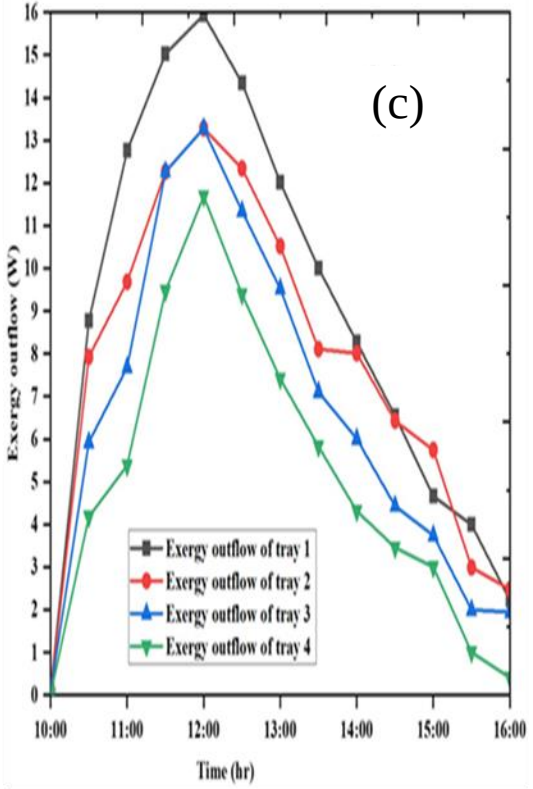
Exergy analysis of trays

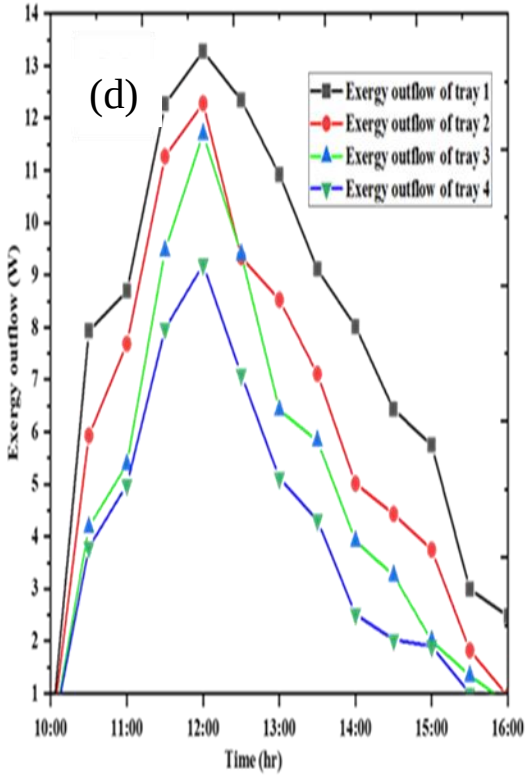
- ❖ The exergy in trays follow expected thermal trends
- ❖ Decreasing exergy with tray depth





Exergy inflow of the trays of dryer 1 (a) and dryer 2 (b)





Exergy outflow of the trays of dryer 1 (c) and dryer 2 (d)

Conclusions

- Drying, especially solar drying, is a vital, sustainable method for food preservation.
- Performance evaluation is essential to ensure efficiency, product quality, and energy sustainability.
- Traditional evaluation methods fall short by overlooking energy quality and system losses.
- Exergy analysis provides a more accurate and comprehensive evaluation by considering both energy quantity and quality.
- Experimental results show that solar drying systems have variable efficiency, peaking around midday.
- Energy and exergy analyses are complementary tools that together enable the design and operation of more efficient, cost-effective, and sustainable drying systems
- Future trends on the field of solar drying

Thank you for your kind attention!