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Technical evaluation of a solar-biomass flatbed dryer for maize cobs drying in Rwanda

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I. INTRODUCTION

The persistent problem of postharvest losses in the maize value chain continues to present a persistent challenge for smallholder farmers in Rwanda. It considerably reduces their ability to negotiate favourable terms in the market, leading to an aggravated disparity in revenues that leaves them more vulnerable. As part of ongoing efforts to address this challenge, a solar-biomass hybrid flatbed dryer for maize cobs drying was designed and constructed in the high-altitude volcanic zone of Rwanda where the issue of postharvest losses is particularly evident. The poster presents results of the dryer's technical performance test runs.

II. METHODS

1. Technical evaluation

The technical drawing of the dryer with positions of different temperature and humidity sensors used in energy balance measurement is shown in Fig. 1. A Bluetooth dongle was used to monitor the performance of the solar system and mass balance was performed by continuous weighting of maize empty cobs supplied to the burner.

Fig. 1: Technical drawing of the dryer with coloured dots the location of different temperature and humidity sensors

2. Drying test runs

Maize cobs, fresh from the field were dried with a constant monitoring of moisture content reduction using a GT5300 grain moisture tester.

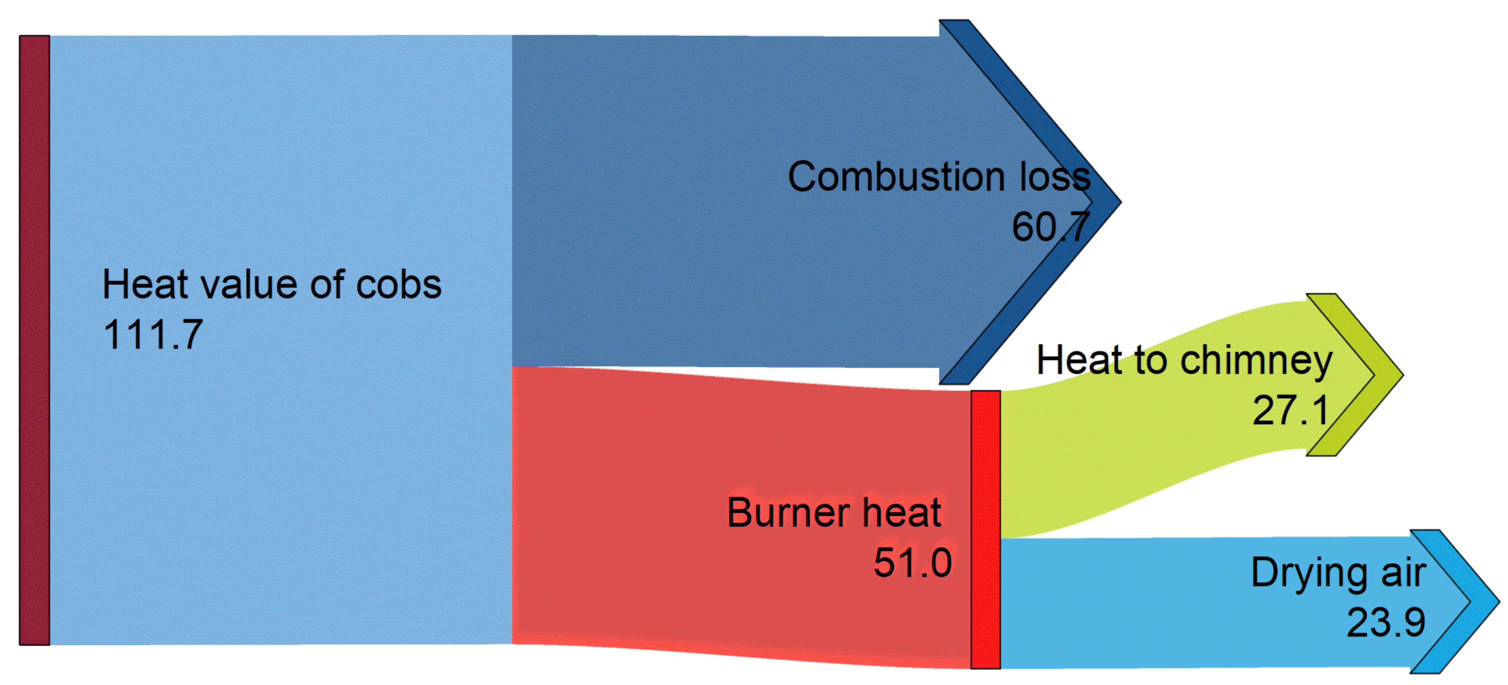

Fig. 2: Heat energy balance for maize cobs drying in MJ (Basis = 1 hour).

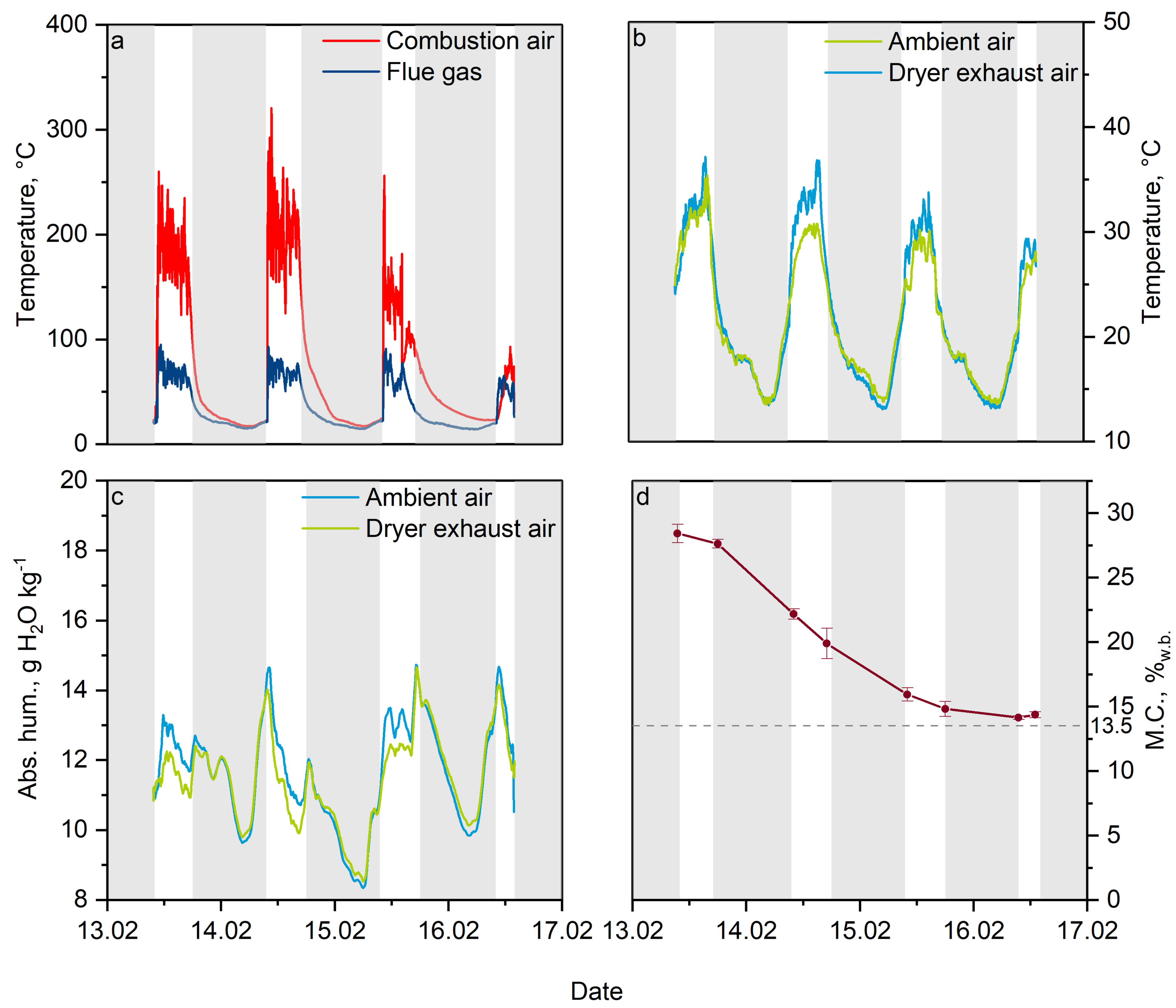

Fig. 3: Temperature of combustion air at outlet of the burner and flue gas in the chimney (a), temperature of the drying air compared to ambient air (b), and the respective absolute humidity (c) shown with drying curves (d)

III. RESULTS

Technical performance of the dryer

The total hourly energy supplied by the empty cobs was 111 kWh (Fig. 2), of which 51.0 % was directly supplied by the burner. The feeding rate of the burner significantly influenced the temperature fluctuation inside the burner as shown in Fig. 3. The temperature in the dryer increased to 35 °C and water uptake can be seen in the rise in absolute humidity. The moisture content reduced from 29 % to 13.5 % within three days of operation.

Performance of the PV system

As shown in Fig. 4, the maximum available energy of the solar system was 6 kWh m^{-2} and during the time of dryer operation, the performance could reach 87.5 % of the maximum daily available energy during cloudy days. Despite fluctuation in daily solar radiations, the test-runs could be conducted without interruption as the system was robustly designed for running the dryer.

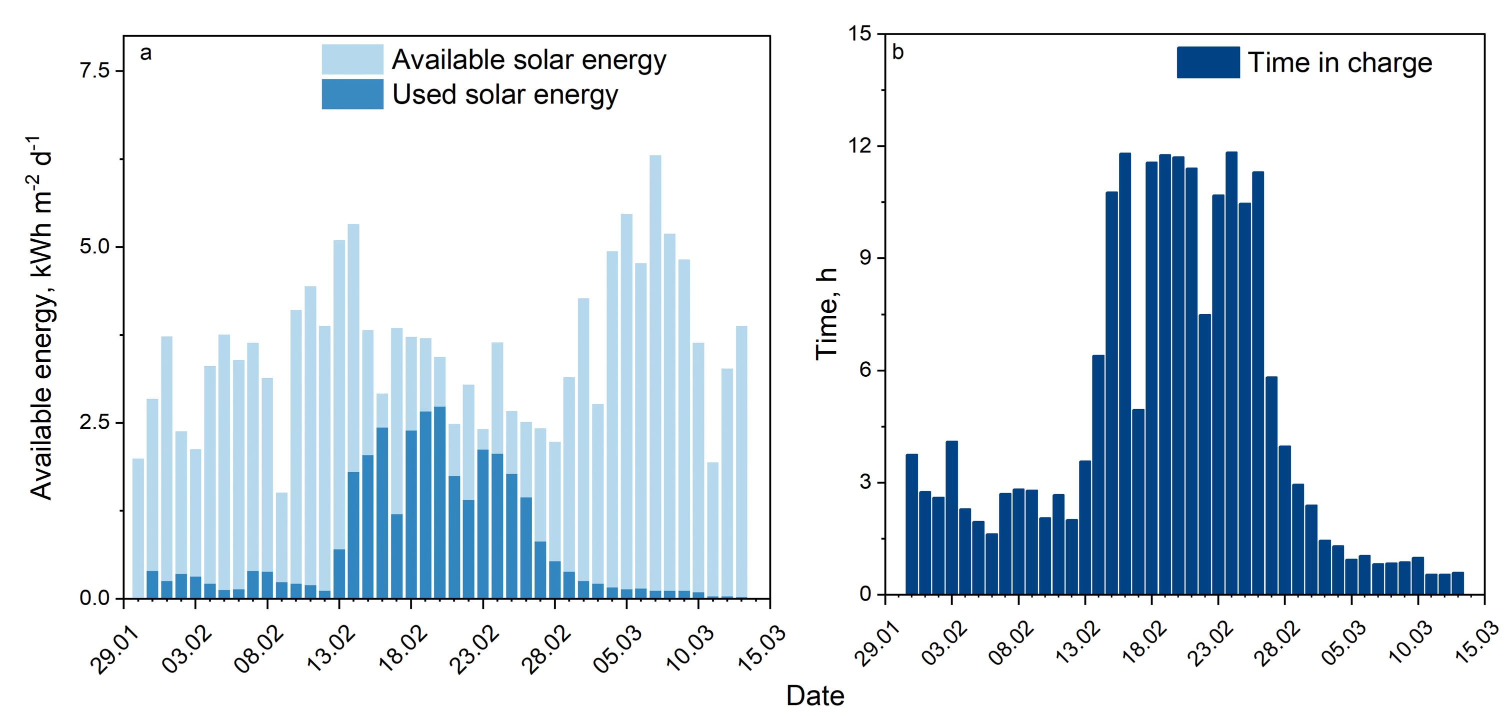

Fig. 4: Solar system performance data records. (a) Yield of the solar system compared to the daily available energy, (b) Total time of charging batteries

IV. CONCLUSION

Drying tests with the newly developed biomass-solar hybrid maize cob dryer revealed that a 48 h drying period is possible with biomass burner running continuously for 24 h. moisture could reduce to the recommended 13.5 % moisture content and the solar system was robust enough to supply energy required for the whole process. A business model is recommended to make the dryer profitable to the farmers' cooperative.

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