SOLAR DRYING OF FAECAL SLUDGE

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PRG
pollution research group

AfricaSan5

FSM5

SUMMARY

I. Introduction

II. Solar drying thermobalance

III. Bench-scale solar drier

IV. Future work

EXPENSIVE PROCESS!

High CAPEX and OPEX

Faecal sludge drying

Volume and mass reduction

Transport cost decrease

Pasteurization

SAFE

Agriculture

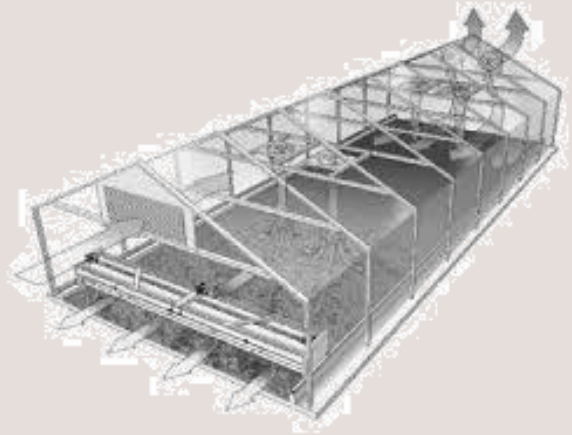
Biofuel

Low moisture content

+ Organic content

SOLAR DRYING, AS A LOW-COST ALTERNATIVE OF CONVENTIONAL DRYING

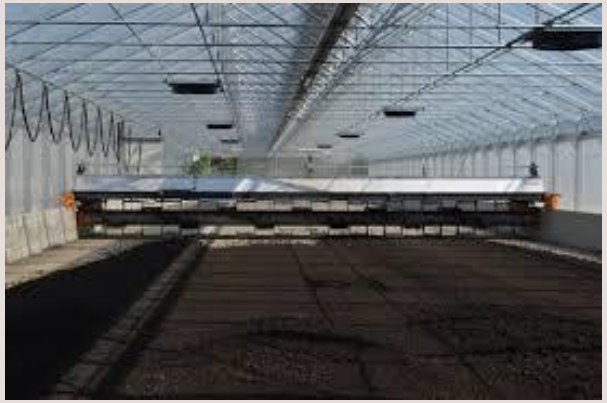
Source: https://recipes.howstuffworks.com/dehydrated-food1.htm



Source: http://www.huber.de/

Source: http://www.tirme.com/es/upload/67pdf_file12_07_31.pdf

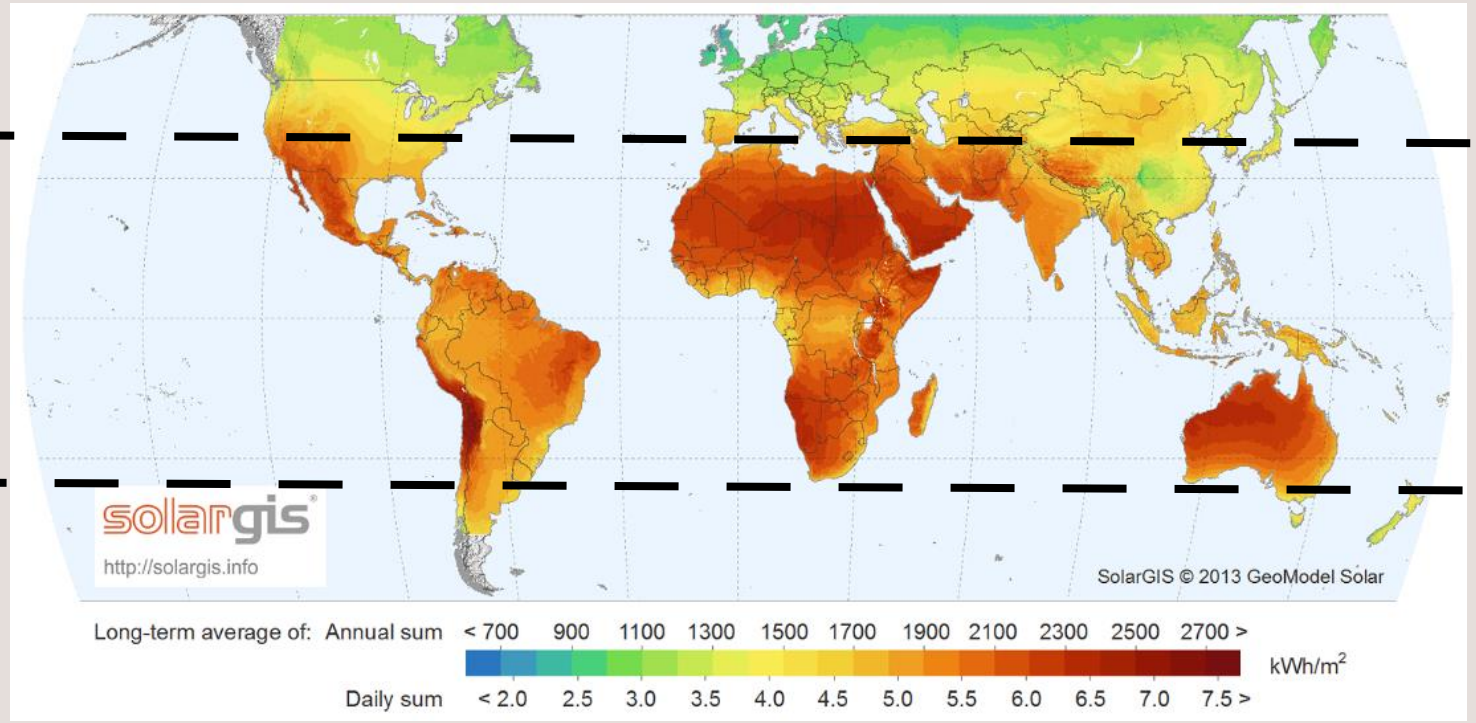
Source: http://iufost.org/wp-content/uploads/05-Solar%20Drying%20Article%20+%20photo.pdf

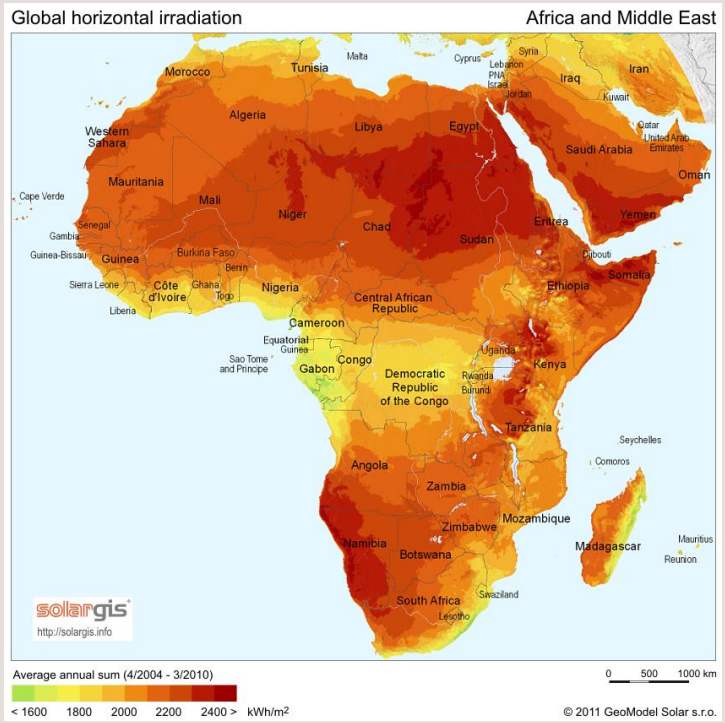


Source: http://www.redco.com.tr

- Most ancient application of solar energy
- Main applications in food industry and crop conservation
- Greenhouses for sewage sludge drying in developed countries
- Largest plant in Mallorca, Spain (treatment 30,000 tonnes of sludge per year)

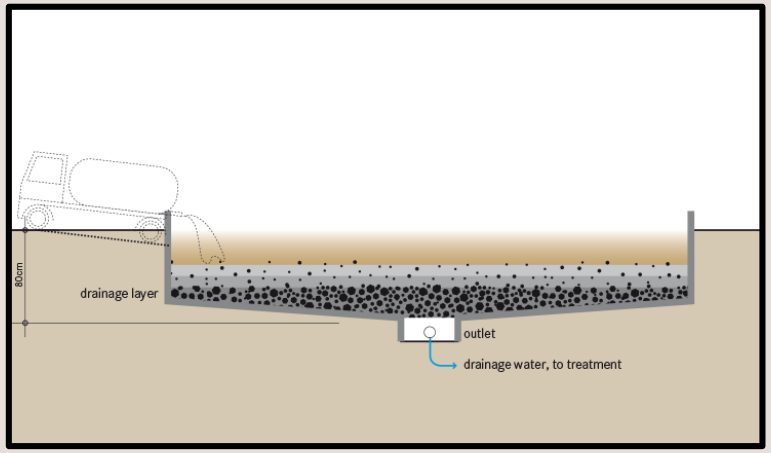
SOLAR ENERGY IN THE WORLD AND AFRICA



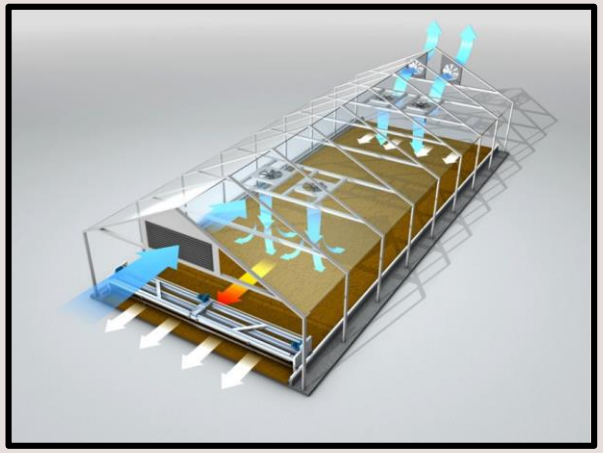


Developing countries facing lack of sanitation (among African countries) situated within the solar belt with the highest irradiances

DRYING BEDS VS SOLAR THERMAL SYSTEM



Source: https://www.huber.de/products/sludge-treatment/sludge-drying/huber-solar-active-dryer-srt.html



Source: https://www.huber.de/products/sludge-treatment/sludge-drying/huber-solar-active-dryer-srt.html

LOW COST

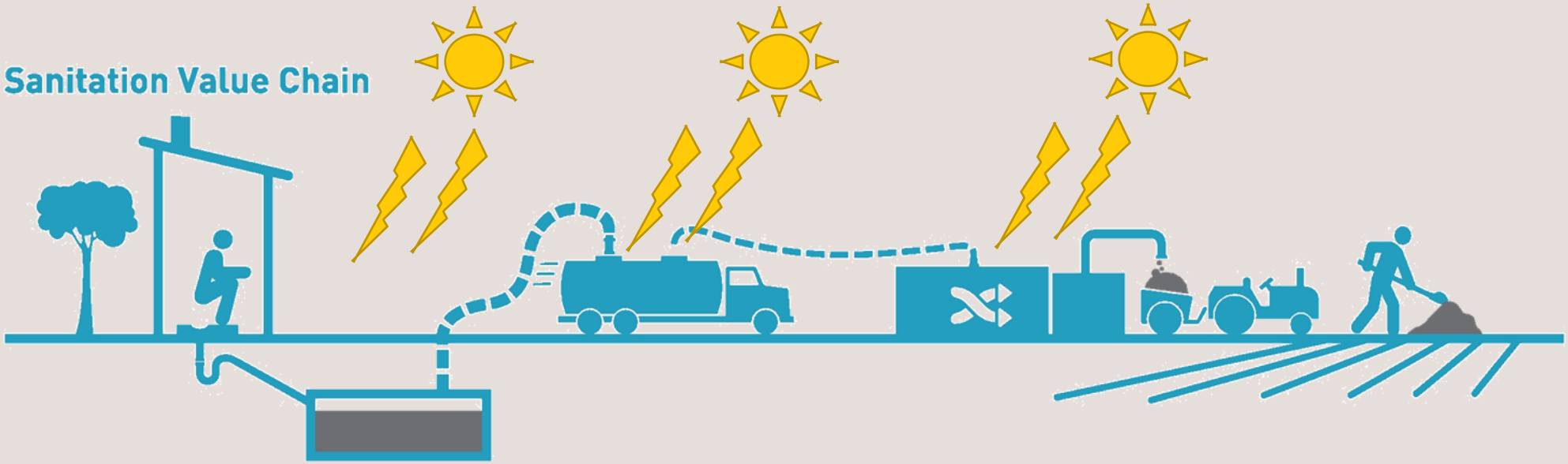
BUT:

- Long drying times
- Possible rehydration
  Large surface area
- Thermal inefficient
- Proliferation of pests
- Pasteurization inefficient
- Intense labour

MORE COST EFFECTIVE SOLUTION

- Lower drying times
- Conditions controlled
- Lower surface area
- Thermal efficient
- Higher temperatures
- Higher pasteurization
- Possibility of automatization

USE OF SOLAR THERMAL ENERGY IN FSM (CURRENTLY LOW)



Source: http://www.climateincorp.com/product-catalog/sani-solar-sanitation/sani-solar-sanitation/

Source: https://www.colorado.edu/solchar/about/our-approach

Source: https://www.susana.org/_resources/documents/default/3-2106-22-1424426286.pdf

Source: https://www.breakingnews.ie/world/fake-poo-project-could-cut-illness-and-deaths-in-developing-countries-814850.html

INVESTIGATIONS AT PRG - UKZN

Generate data and knowledge about faecal sludge solar drying through experimental work at laboratory scale

Increase awareness about faecal sludge solar drying

Support the improvement of existing technologies

Promote the development of innovations and new technologies

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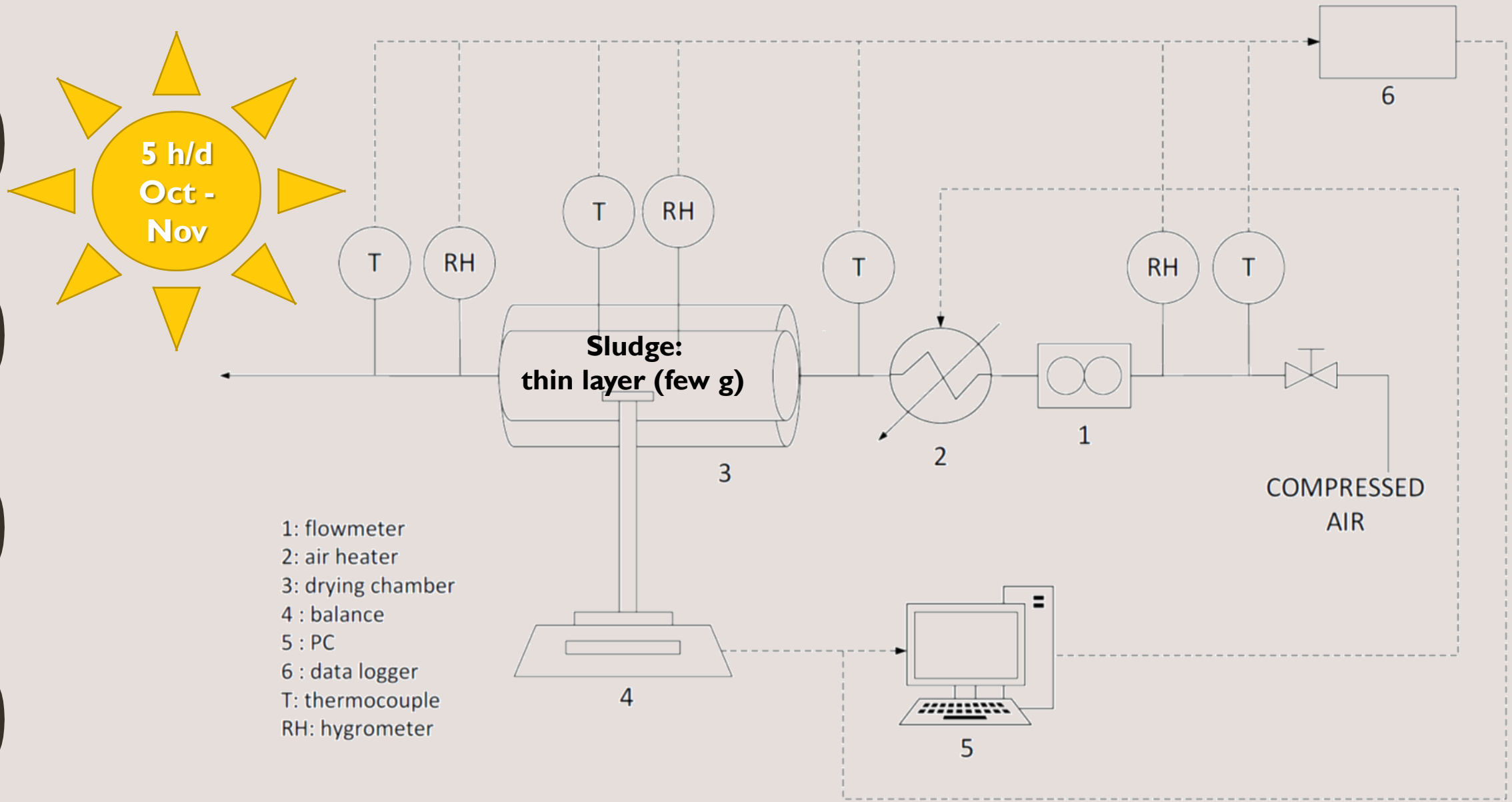
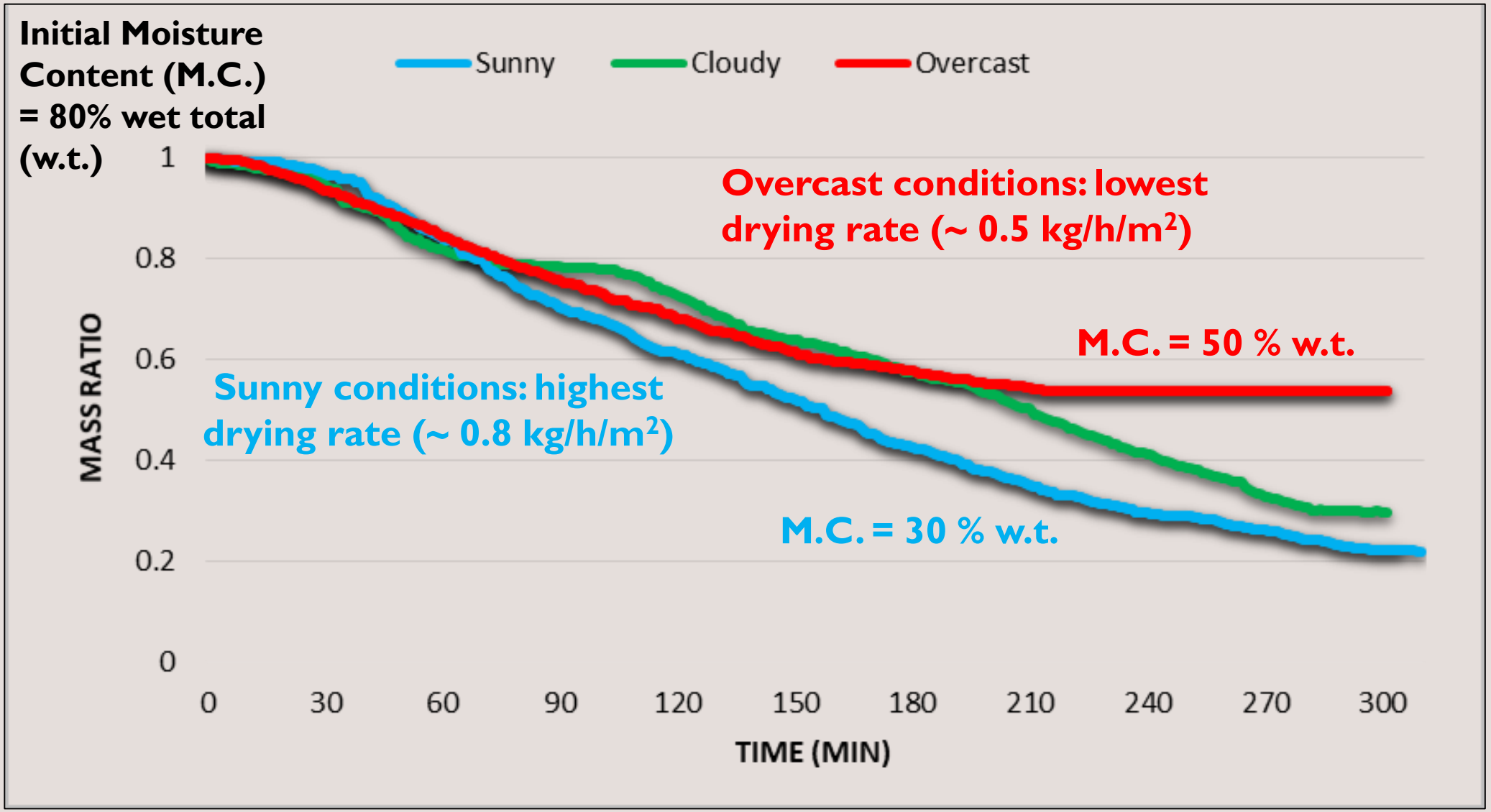
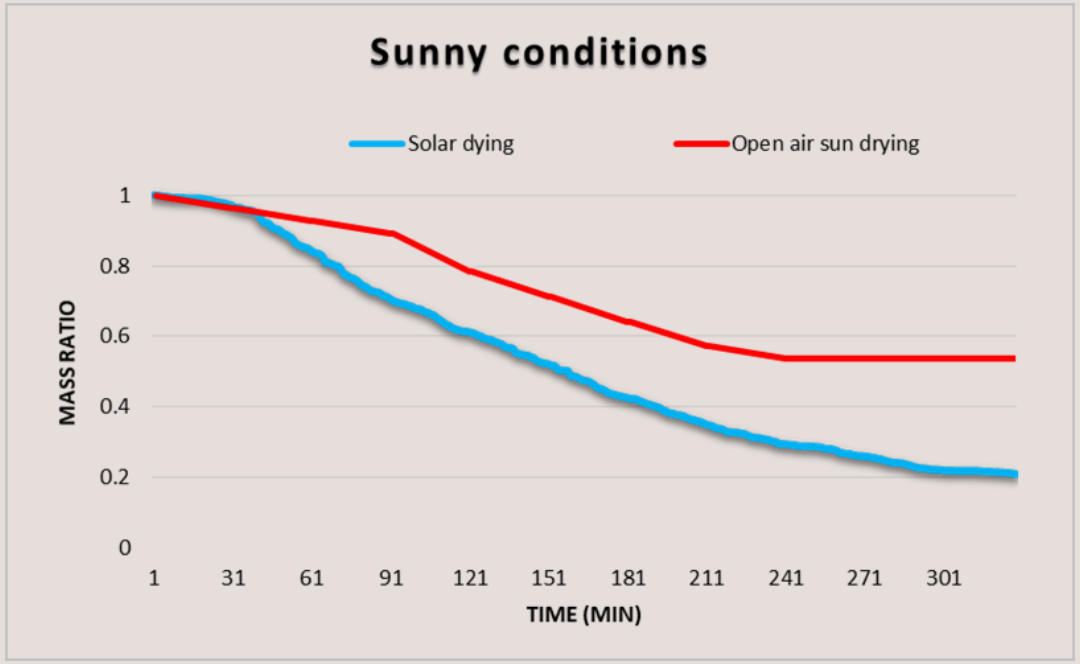
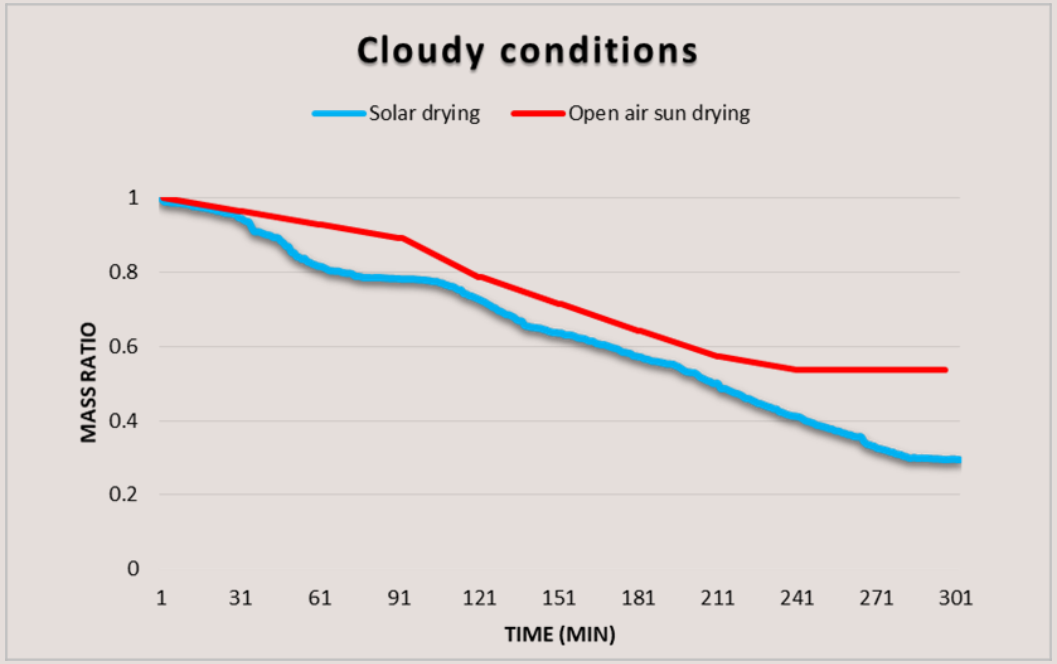
EXPERIMENTAL SETUP

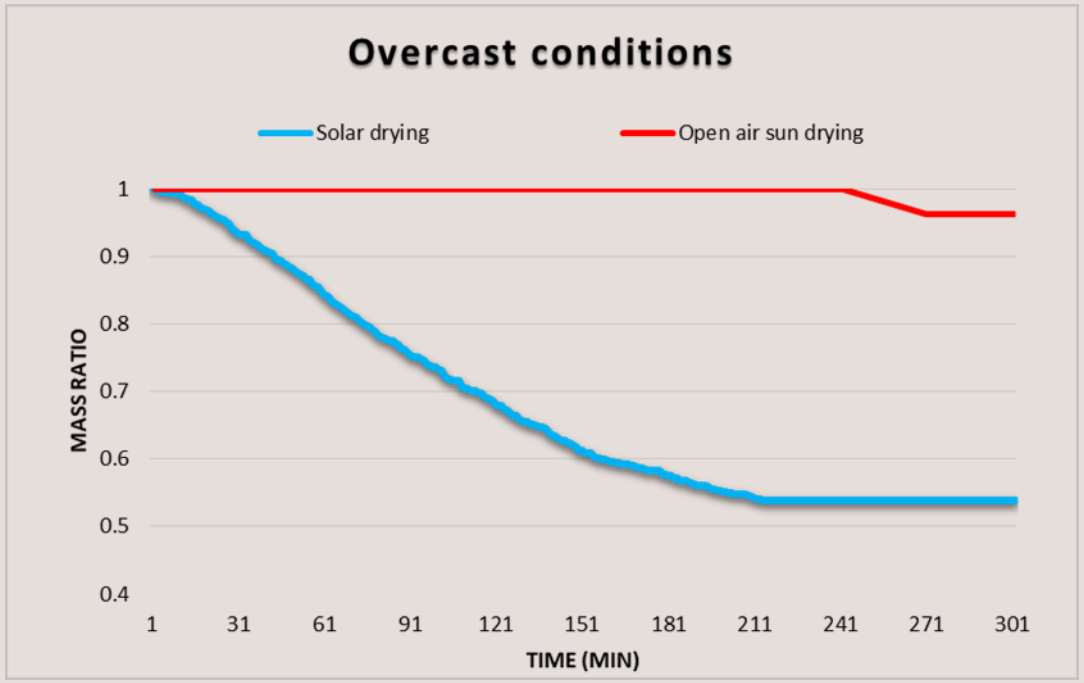


EFFECT OF WEATHER CONDITIONS









Better performance of solar drying compared to open-air drying

Highest difference in overcast conditions

OUTCOMES FROM THE INVESTIGATION

After 5 hours of solar drying in the spring in Durban:

- Moisture reduction between 60 to 95%
- Drying rate between 0.5 and 1.0 kg/h/m2
- Temperatures up to 40°C (+20°C than ambient temperature)

Challenges:

- Crust formation
- Variability weather conditions

Surface area of a soccer pitch (4500 m^2):

Source: https://www.mmstadium.com/news/rhinos/

- 5 ton / h
- 2.5 ton / year / m^2
  (5-8 hours of operation)

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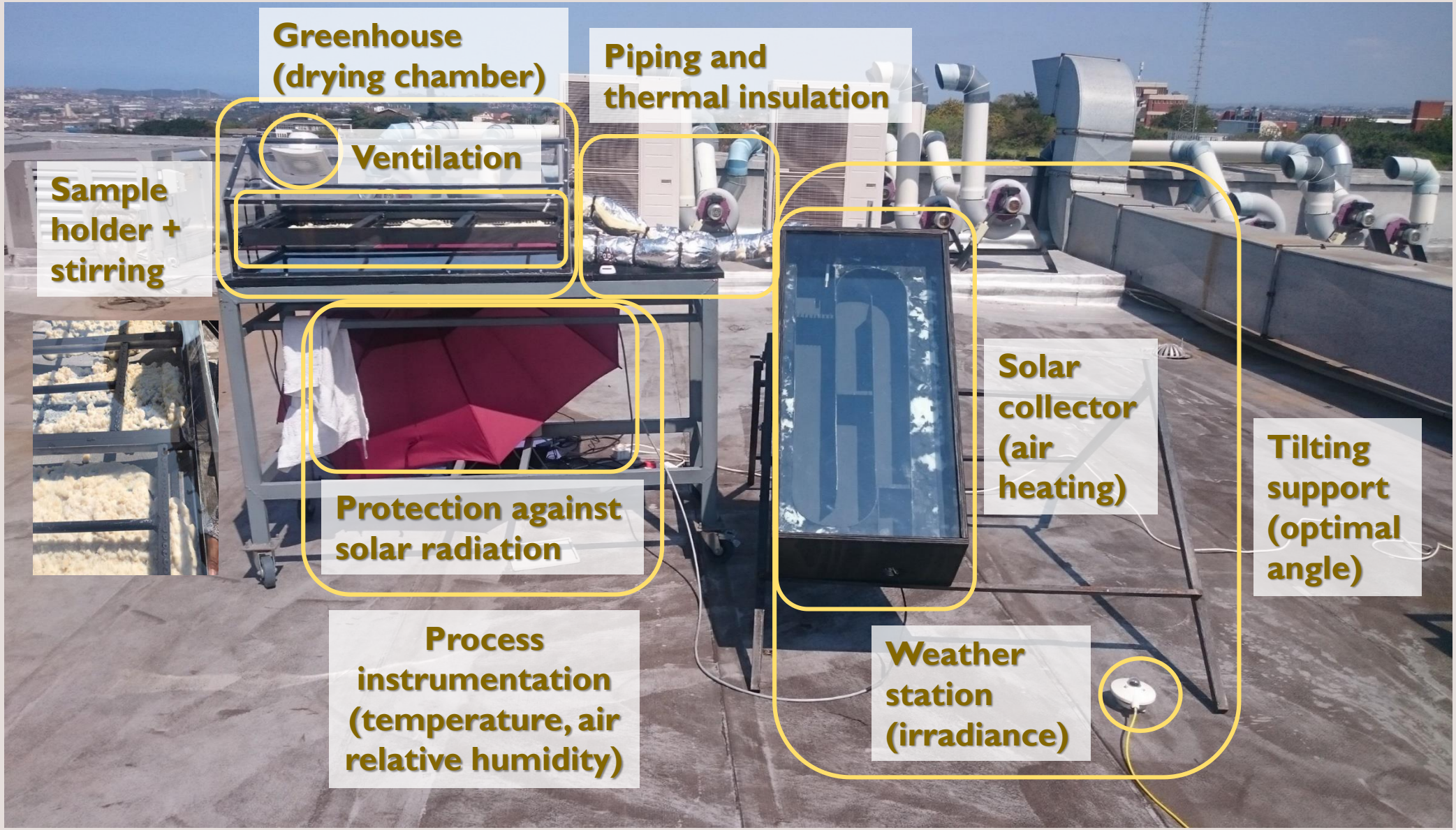
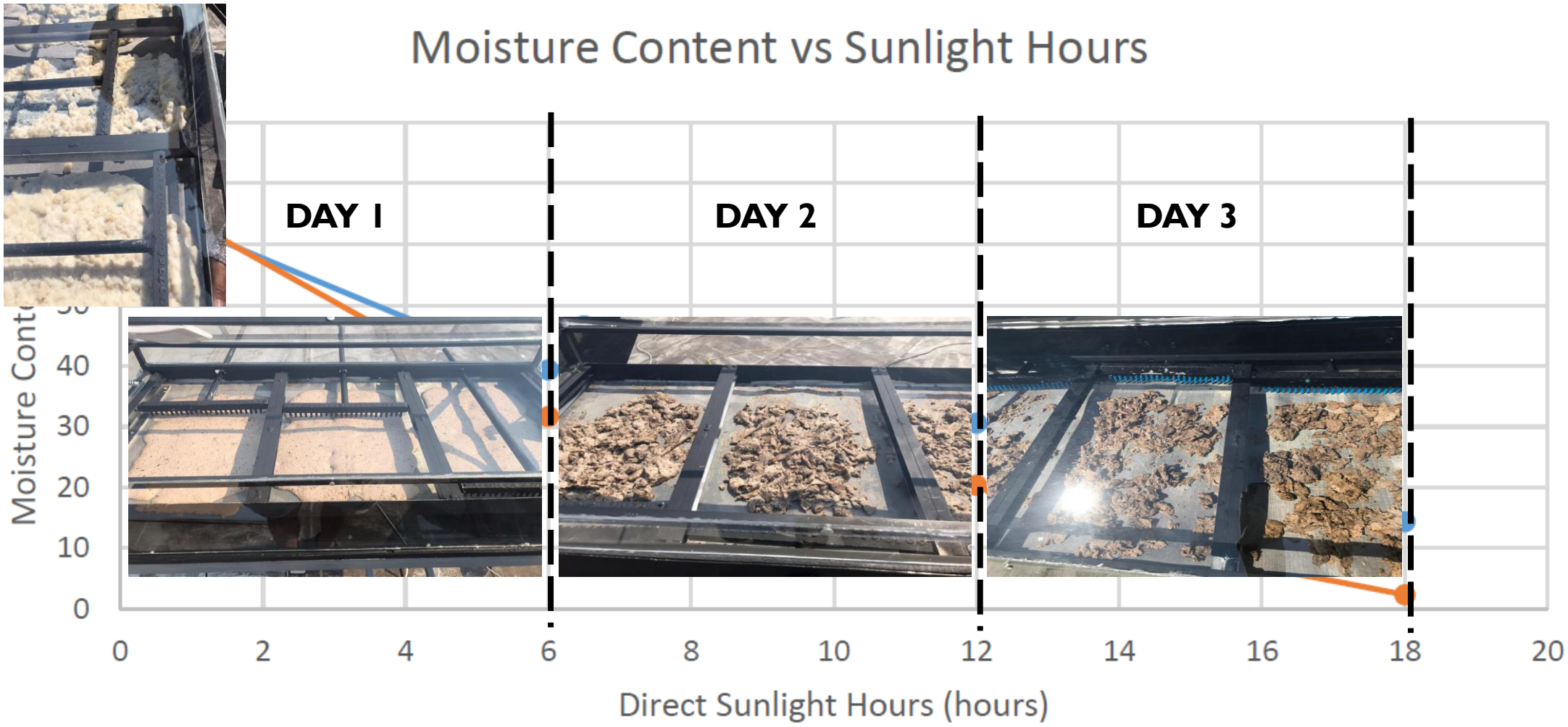
DEVELOPMENT OF A SOLAR DRIER



TRIAL WITH SYNTHETIC SLUDGE (OCTOBER)



SPECIFICATIONS OF SOLAR DRYER

Parameter	Value
Mass of sludge	4.5 kg
Operation time	9 h/d
Surface area	0.34 m^2
Air temperature	50 - 80°C
Energy consumption (25 W fan)	0.225 kWh/d (80 kWh/y)
Drying rate	0.5 kg/h/m^2 (1.5 ton/y/m^2)
Performance process	0.150 kWh/kg (150 kWh/t)

Conventional dryers: 800 – 1000 kWh/t

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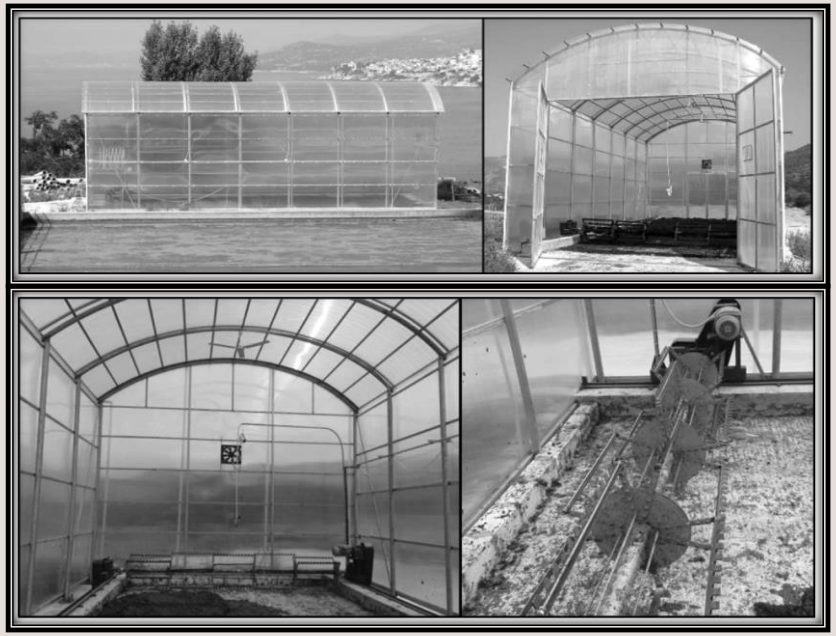
FUTURE WORK

Continuation of the current investigations with a Master project and intern, in order to generate further data and understanding

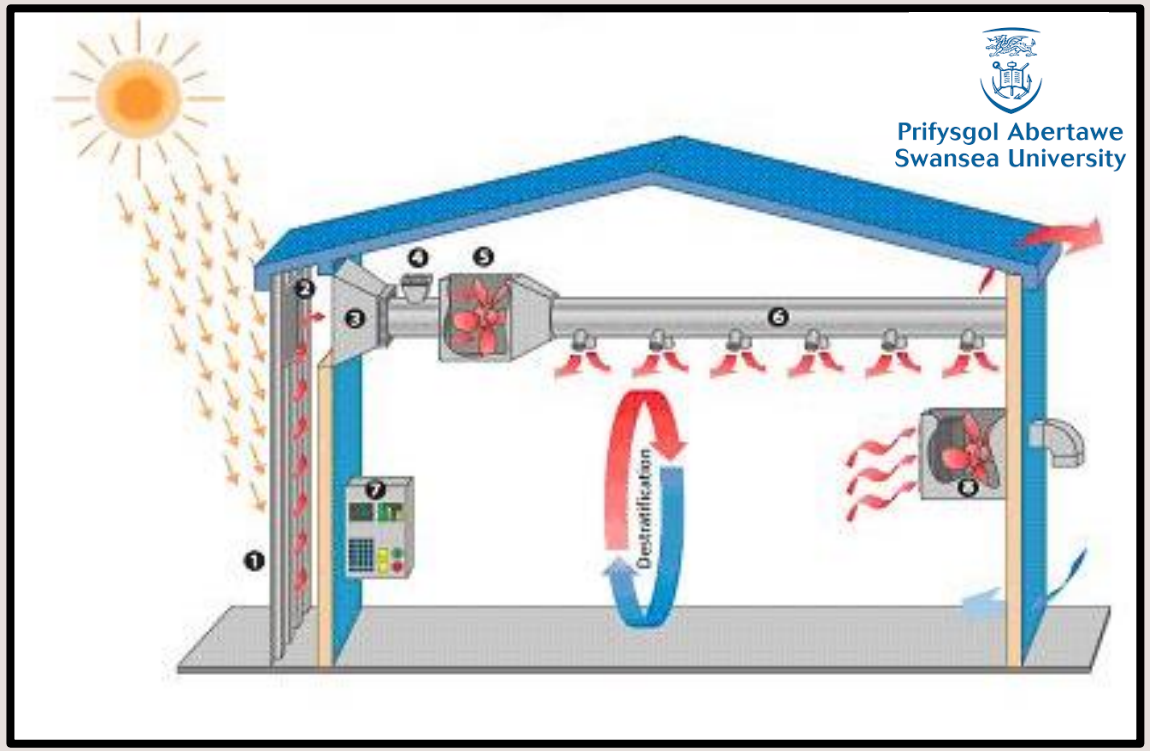
Development of a solar drying technology at pilot-scale in order to provide cost effective solutions for faecal sludge treatment



Source: Mathioudakis, V.L., Kapagiannidis, A.G., Athanasoulia, E., Paltzoglou, A.D., Melidis, P., Aivasidis, A., 2013. Sewage sludge solar drying: Experiences from the first pilot-scale application in Greece. Dry. Technol. 31, 519–526./

FUTURE WORK

Engineering field testing of a solar dryer developed by Swansea University



Source: https://www.tatasteelconstruction.com/en_GB/Products/Building-envelope/Walls/active-solar-air-heating/Colorcoat-Renew--SC%C2%AE

Development of Centre of expertise on solar drying and faecal sludge drying

ACKNOWLEDGMENTS

Water Research Commission
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Technical staff from the Pollution Research Group, Chemical & Mechanical Engineering department (laboratory, workshop, administrative)

THANKS FOR YOUR LISTENING

Reports and papers from this project available by request

In research of partners and a motivated master student for the new project about the development of a solar drier

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