THE UNIVERSITY *of* EDINBURGH
School of Engineering

A low-energy approach to process large scale airflow

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Background / Motivation

- ❑ Greenhouse Gas Removal (GGR) at a large scale requires sufficient airflow [1], which is energy-intensive.
- ❑ Solar updraft devices (e.g. Trombe wall, double skin facade) as a simple building component, absorbing solar energy for heating or ventilation [2].
  - Simple construction
  - Zero operation cost
  - Zero energy input
  - Environmentally friendly

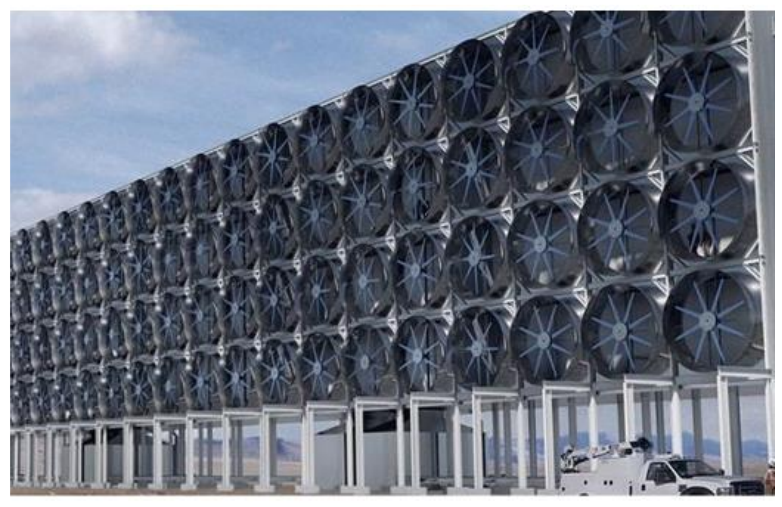

Image Credit: Carbon Engineering Ltd

Fig. 1. Carbon Engineering DAC concept.

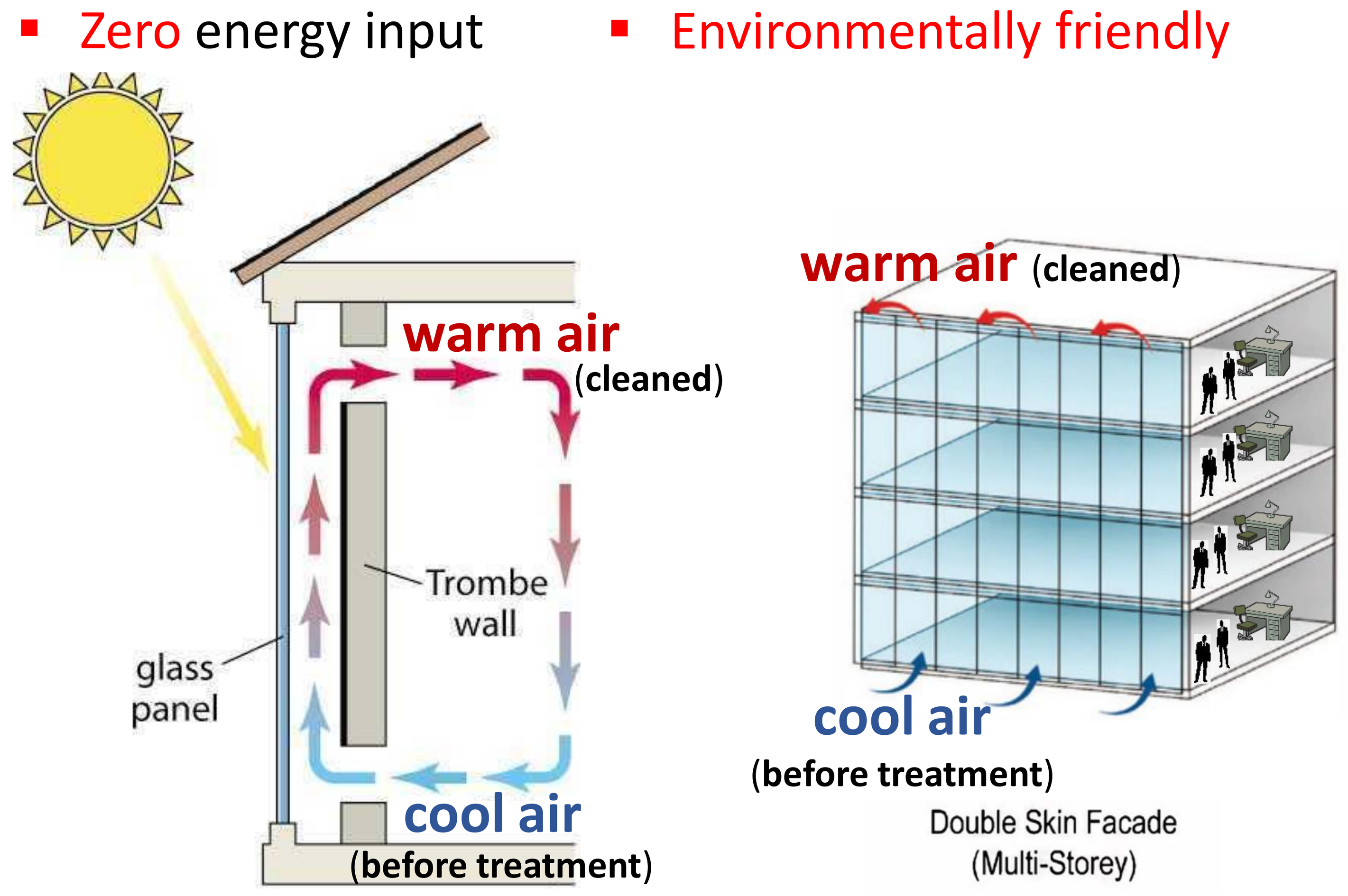

Fig. 2. Solar updraft devices.

- ❑ Can the technology be deployed around the globe? i.e. can moderately low solar radiation (e.g. in most European countries) generate sufficient updraft?

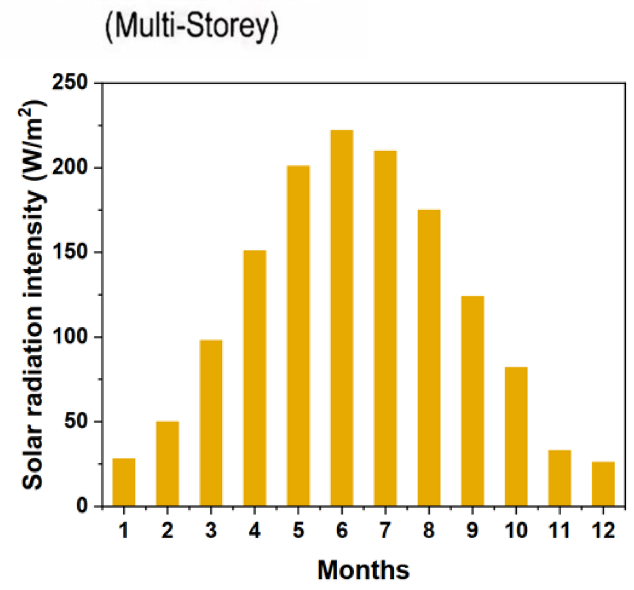

Fig. 3 Monthly average solar radiation in south England, the highest solar radiation intensity is below 250 W/m² [3].

Aims

- ❑ Investigate air flow of new Trombe wall under low solar radiation (from 100 W/m² to 600 W/m²)
  - A fast-analytical math model & CFD simulation
  - Buildup test rig & data collection

Experimental setup / Data collection

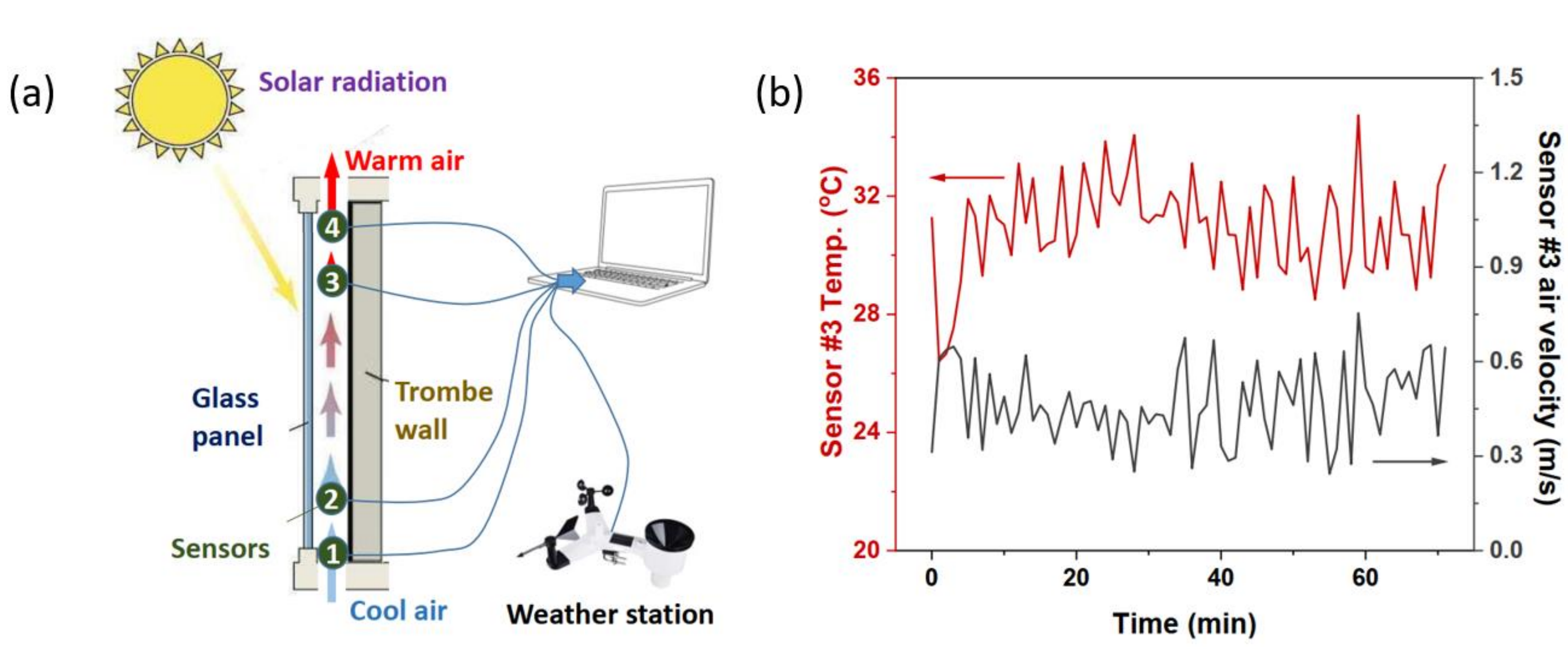

Fig. 4. a) Test rig (2 x 0.5 x 0.12 m); b) Temperature and air velocity under 397 W/m2 solar intensity.

- ❑ Four sensors were fitted in the airflow channel to measure airflow temperature and velocity.

Model validation

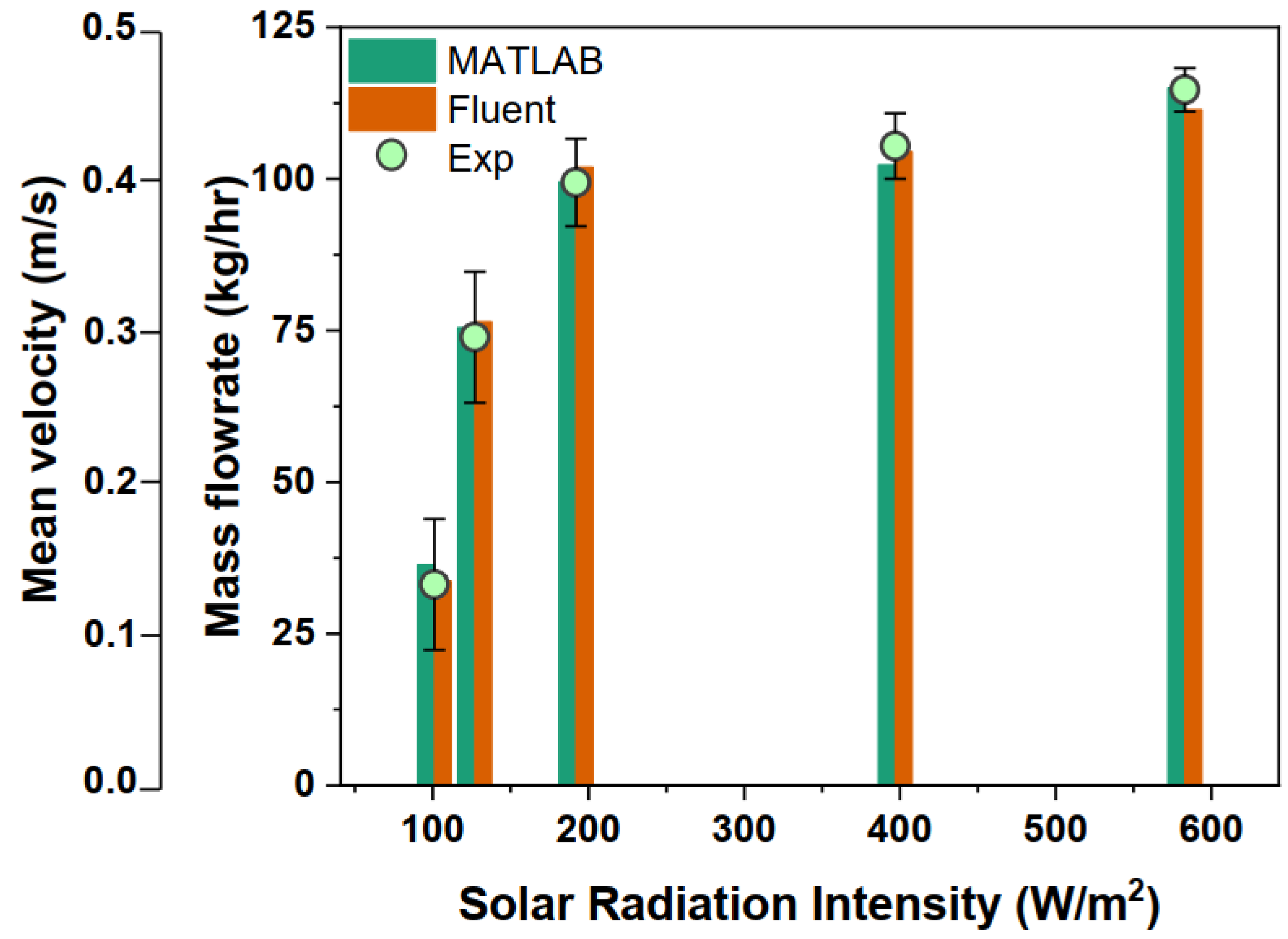

Fig. 5 Mass flow rate and Velocity under different solar intensity.

- ❑ Two models fit well with experimental data.
- ❑ A Trombe wall can generate 75.6 kg/hr airflow under 120 W/m² solar radiation.

Model prediction

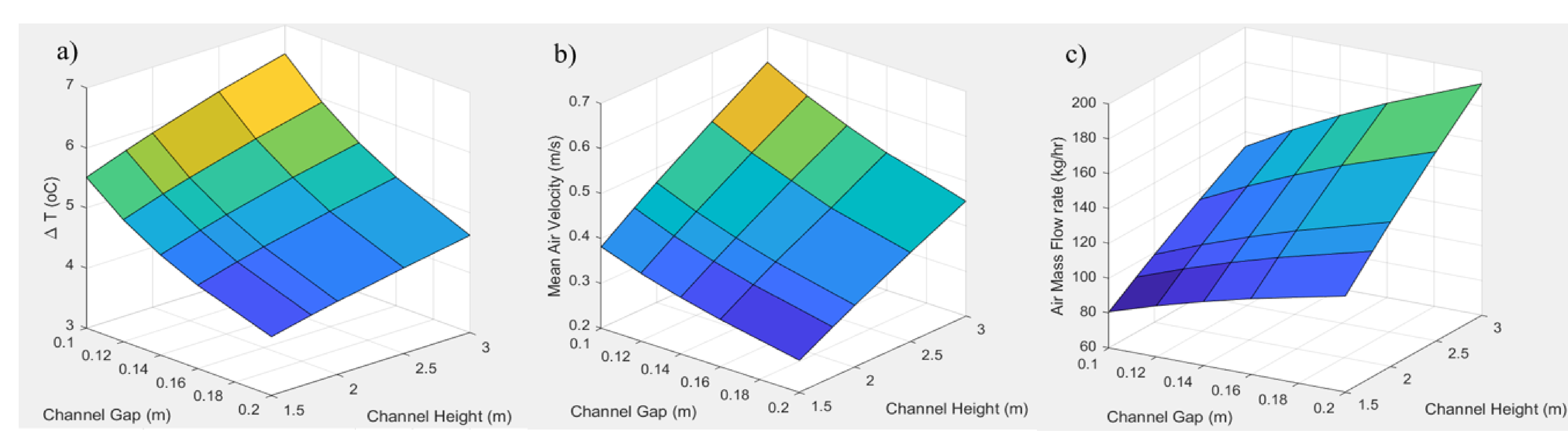

Fig. 6. a) ΔT (air temperature); b) air Velocity; c) air Mass flow rate.
H : Channel Height; ***G***: Channel Gap; ***V***: air velocity; ***HT***: Heat Transfer

- ❑ ***H*** ↑ -> Area ↑ -> Solar Flux ↑ -> ***ΔT*** ↑ -> Buoyancy ↑ -> ***V*** ↑
- ❑ ***G*** ↓-> ***HT*** distance ↓ -> ***ΔT*** ↑ -> Buoyancy ↑ -> ***V*** ↑
- ❑ ***H*** and ***G*** ↑ -> volume ↑ -> Mass flow rate ↑

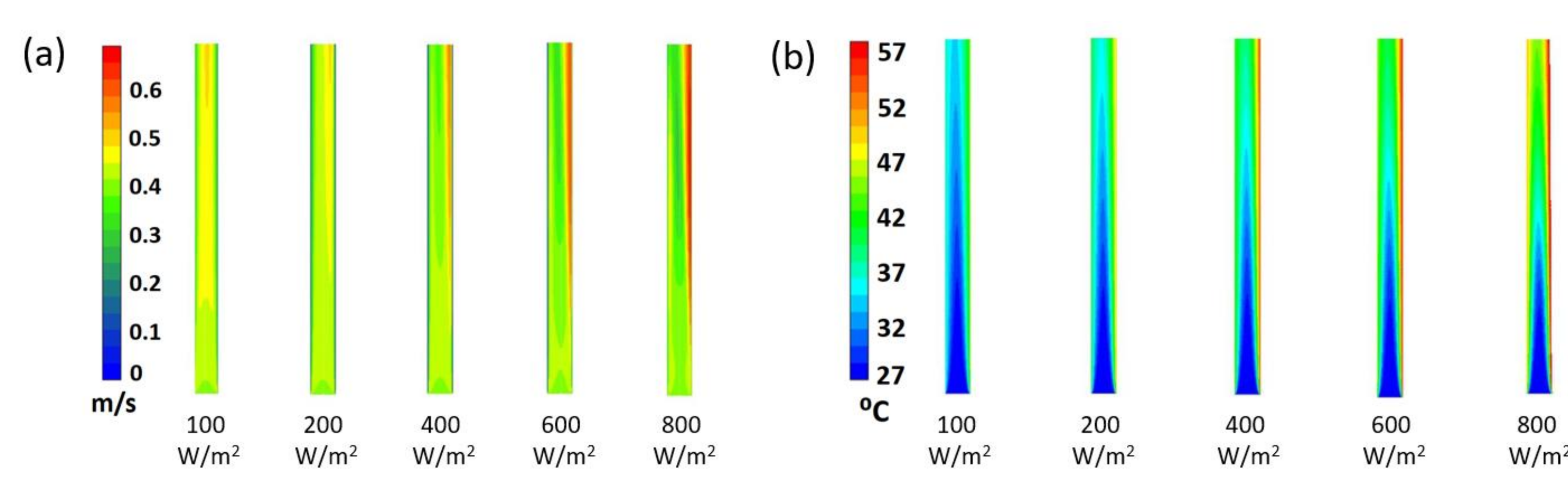

Fig. 7. a) Velocity contour; b) ΔT contour under different solar intensity.

- ❑ The air temperature and velocity are unevenly distributed.
- ❑ The air closer to the wall is more vulnerable to receive convective heat.

References, Funders and Collaborators

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[2] Harrison*. et al. Renew. Energy 2014, 71, 333.
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