

Adsorption Cooling for India's Cold Chain

Creating Useful Cold with Waste Heat

Adam Rieth, Dr. Selma Duhović, Prof. Mircea Dincă

Massachusetts Institute of Technology

TATA CENTER
TECHNOLOGY + DESIGN



Massachusetts
Institute of
Technology

Problem:

Agricultural Sector Production:

81 billion kg fruits & 162 billion kg veg.²

GDP:

17% of India, 350 billion dollars²

Annual Waste:

40-50% F&V² and 20-30% fish¹

Why?:

Lack of Cold Chain due to Poor
Electricity Supply!

Cold Chain Market size

\$2.0B (2009), \$4.7B (2013), \$12.8B
(2017)¹

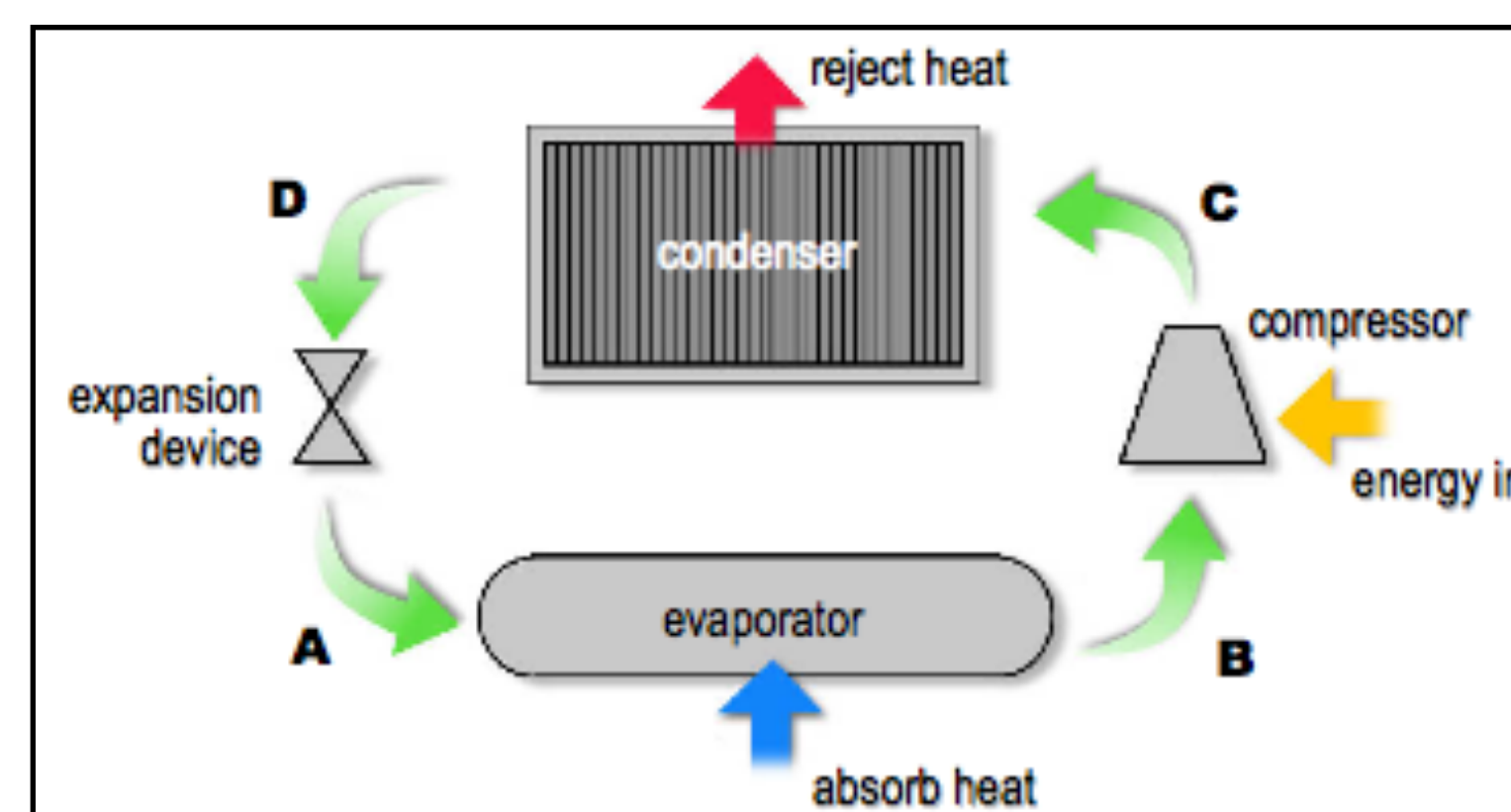
Capacity:

<11% of production of perishables

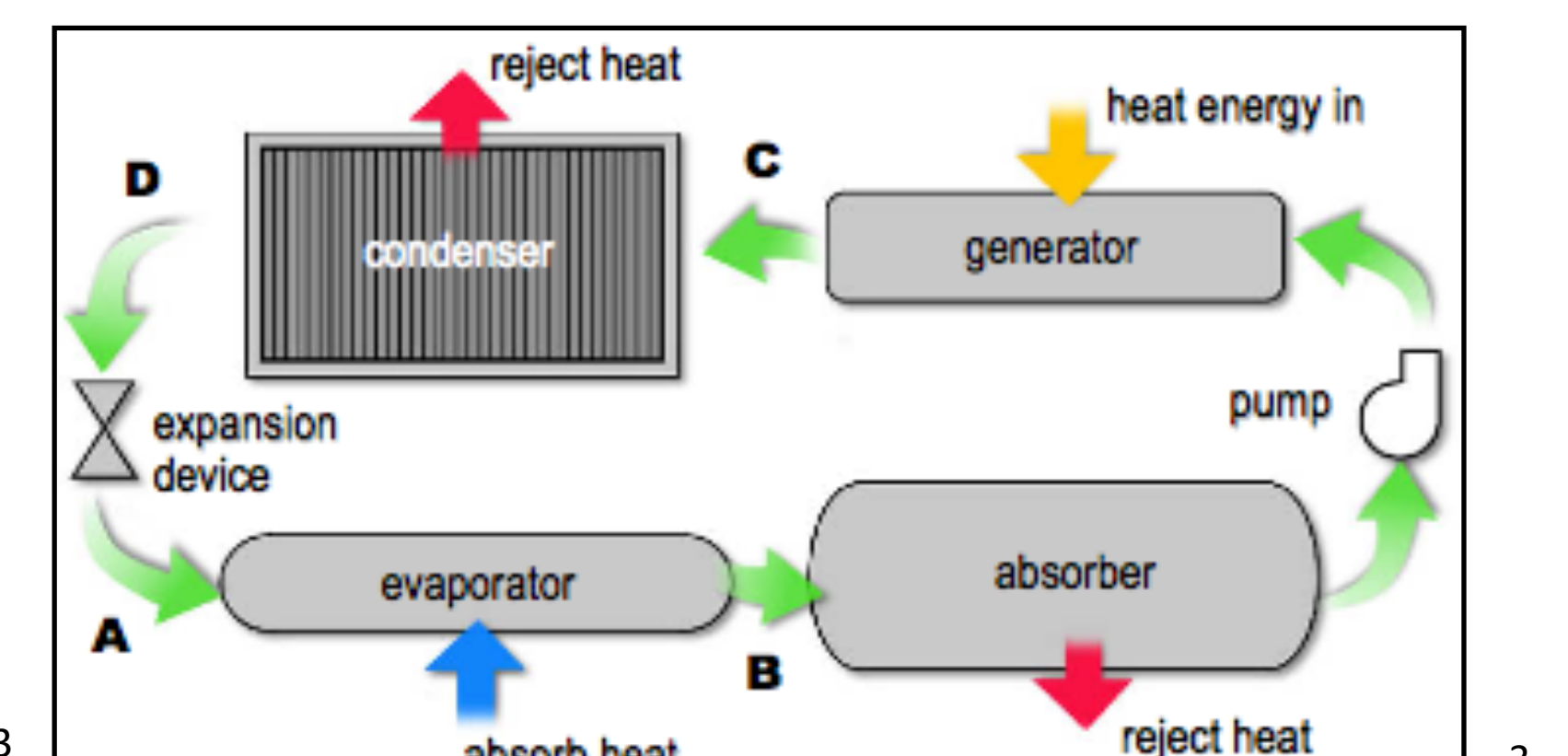
Proposed Solution:

Off-Grid Adsorption Cooling Systems

- Adsorption Heat pumps may be powered by waste heat from an engine or generator.
- Cogeneration of heat with electricity greatly improves the efficiency of energy utilization of a fuel.
- Novel high surface area adsorbents called Metal-Organic Frameworks allow tuning of pressure of refrigerant adsorption, and adsorb much more refrigerant.
- Miniaturization of adsorption systems with improved sorbents will allow integration into mobile refrigerated trucks, as well as village-scale crop cold storage.



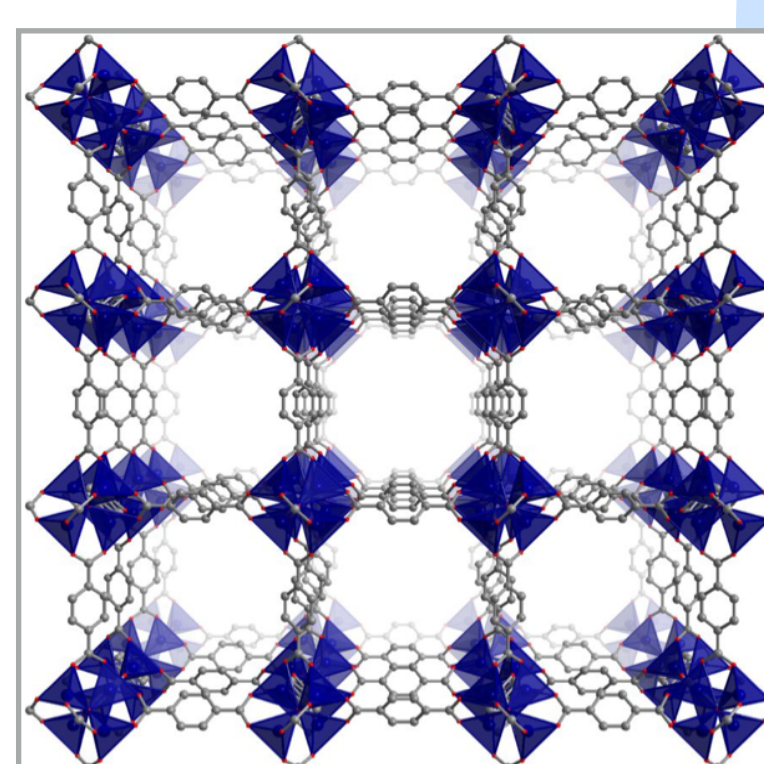
Compression cooling cycle
uses electricity and ozone-depleting refrigerants



Sorption cooling cycle
uses waste heat, water, and sorbents.

Chemistry

–Can we design and synthesize high surface area water-stable materials?

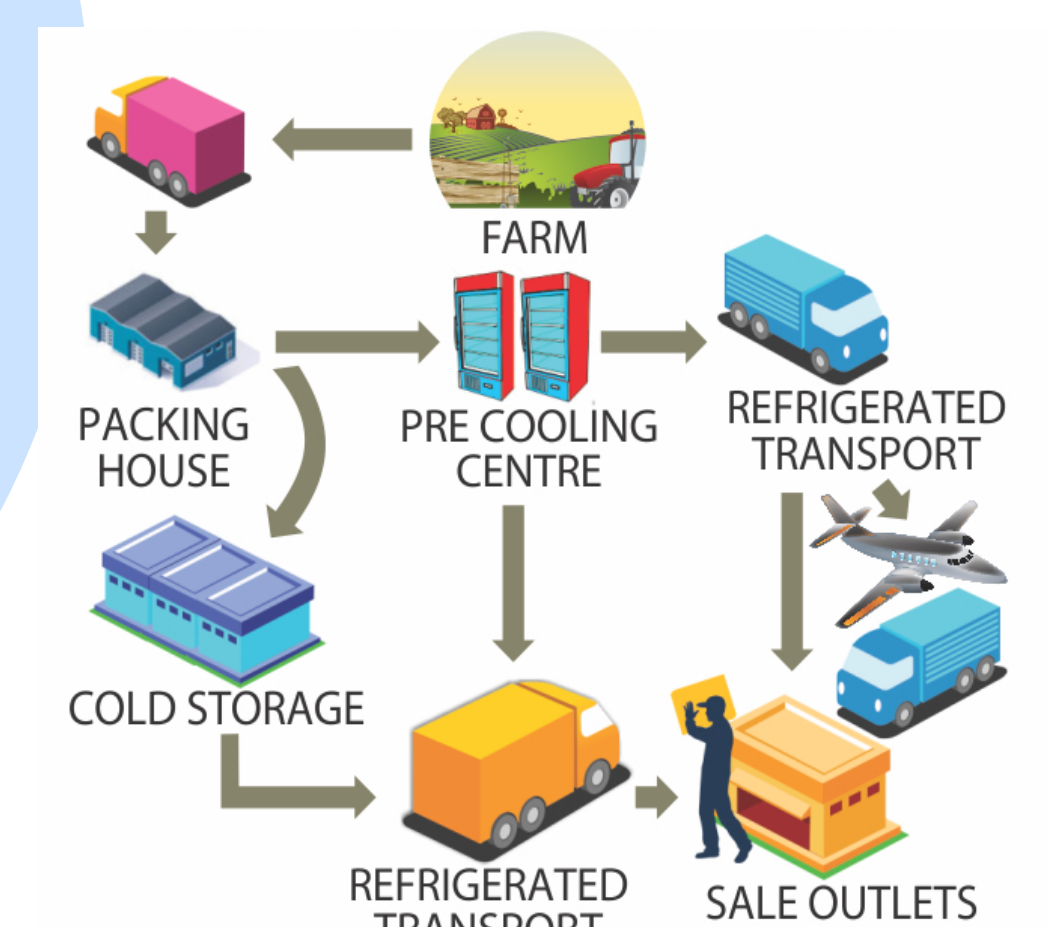


Engineering

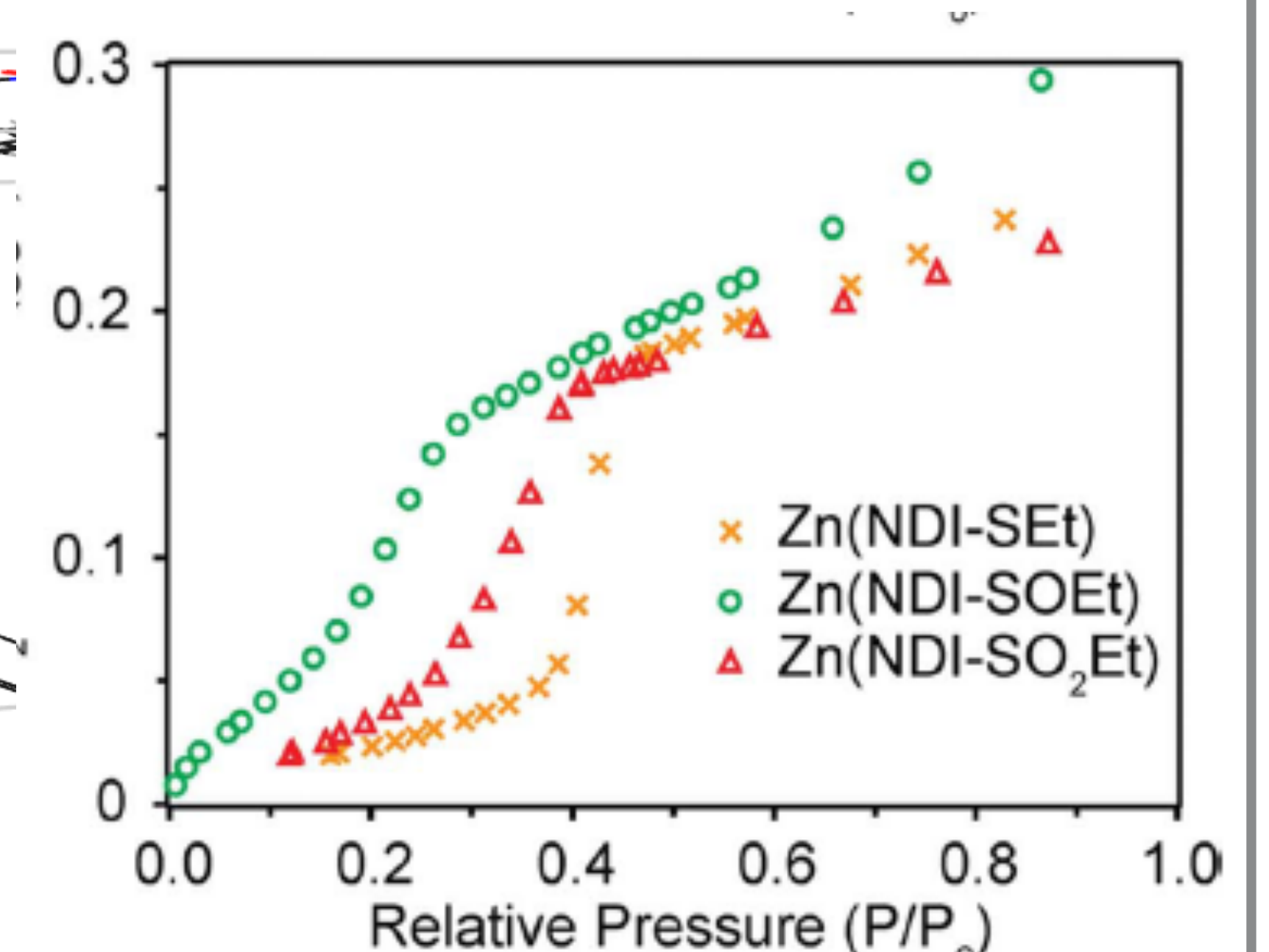
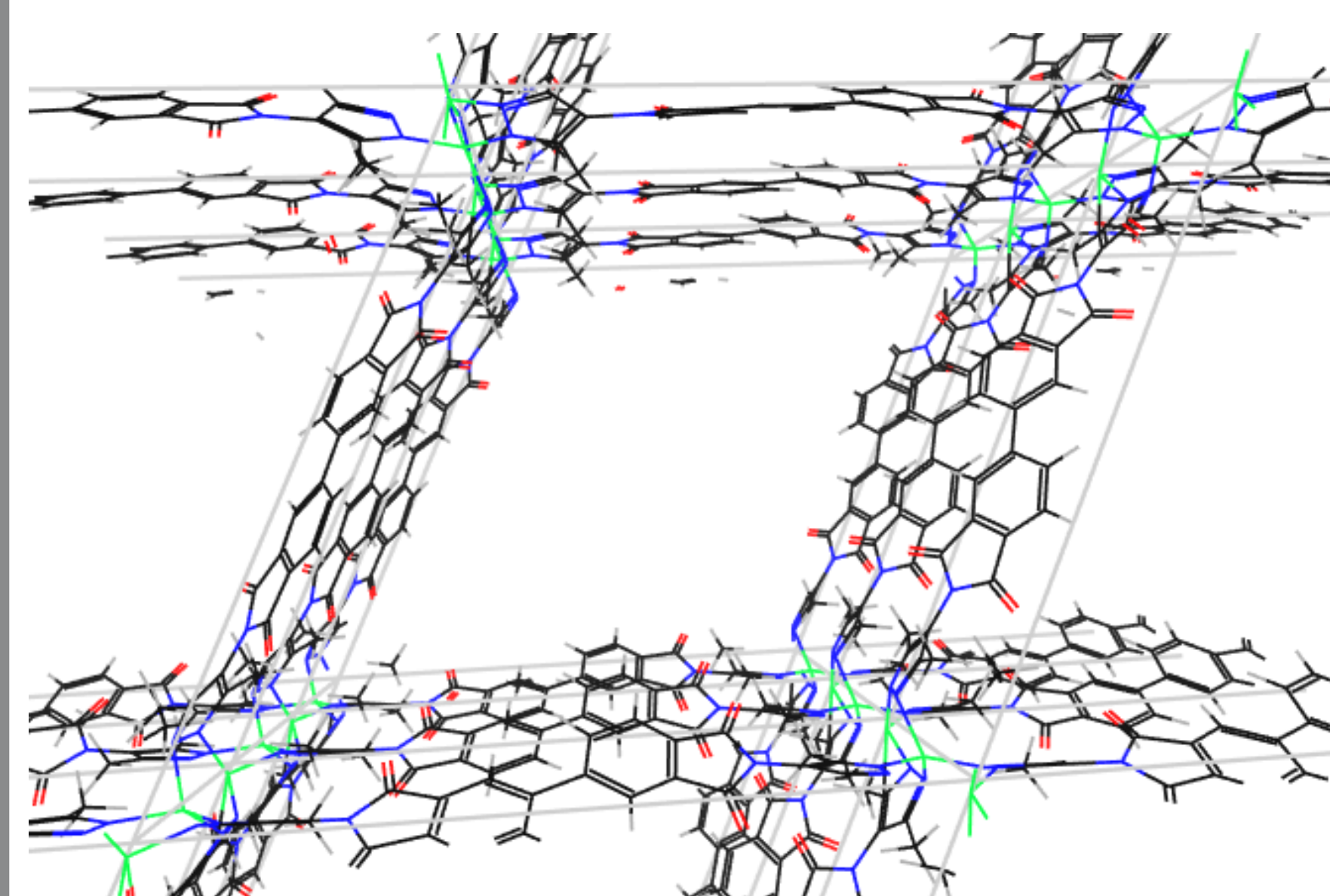
–Are our materials scalable?
–Can we incorporate them into a functional device?

Implementation

–Does it economically solve the problem of off-grid cold storage?



New Materials: Large Uptakes, Tunable Isotherms



References

1. Assocham, US Commercial Service, Reed Analysis
2. YES Bank-Dutch Embassy Collaborative Study
3. Trane; A Handbook on Low-Energy Buildings and District-Energy Systems
4. Wade, Dincă. et. al. *Energy Environ. Sci.* **2013**, *6*, 2172.

Acknowledgements

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